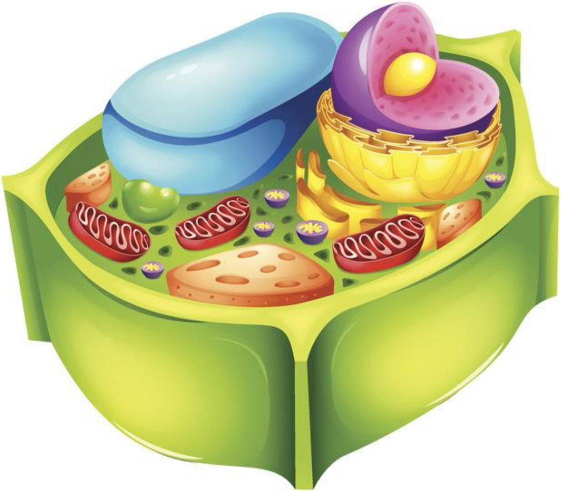
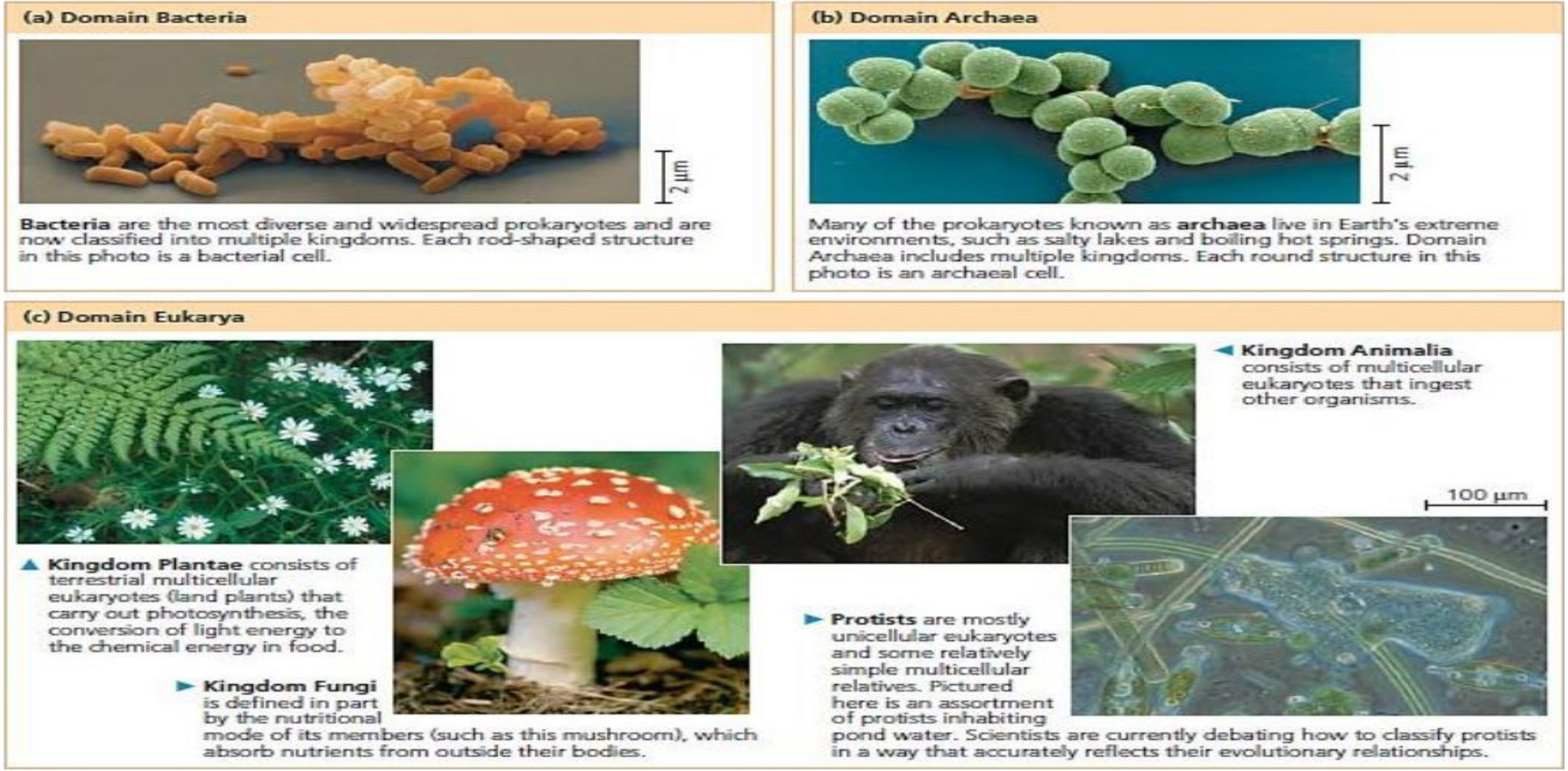
CELL : THE FUNDAMENTAL UNIT OF LIFE

animal cell



plant cell



(a) Domain Bacteria

Bacteria are the most diverse and widespread prokaryotes and are now classified into multiple kingdoms. Each rod-shaped structure in this photo is a bacterial cell.

(b) Domain Archaea

Many of the prokaryotes known as **archaea** live in Earth's extreme environments, such as salty lakes and boiling hot springs. Domain Archaea includes multiple kingdoms. Each round structure in this photo is an archaeal cell.

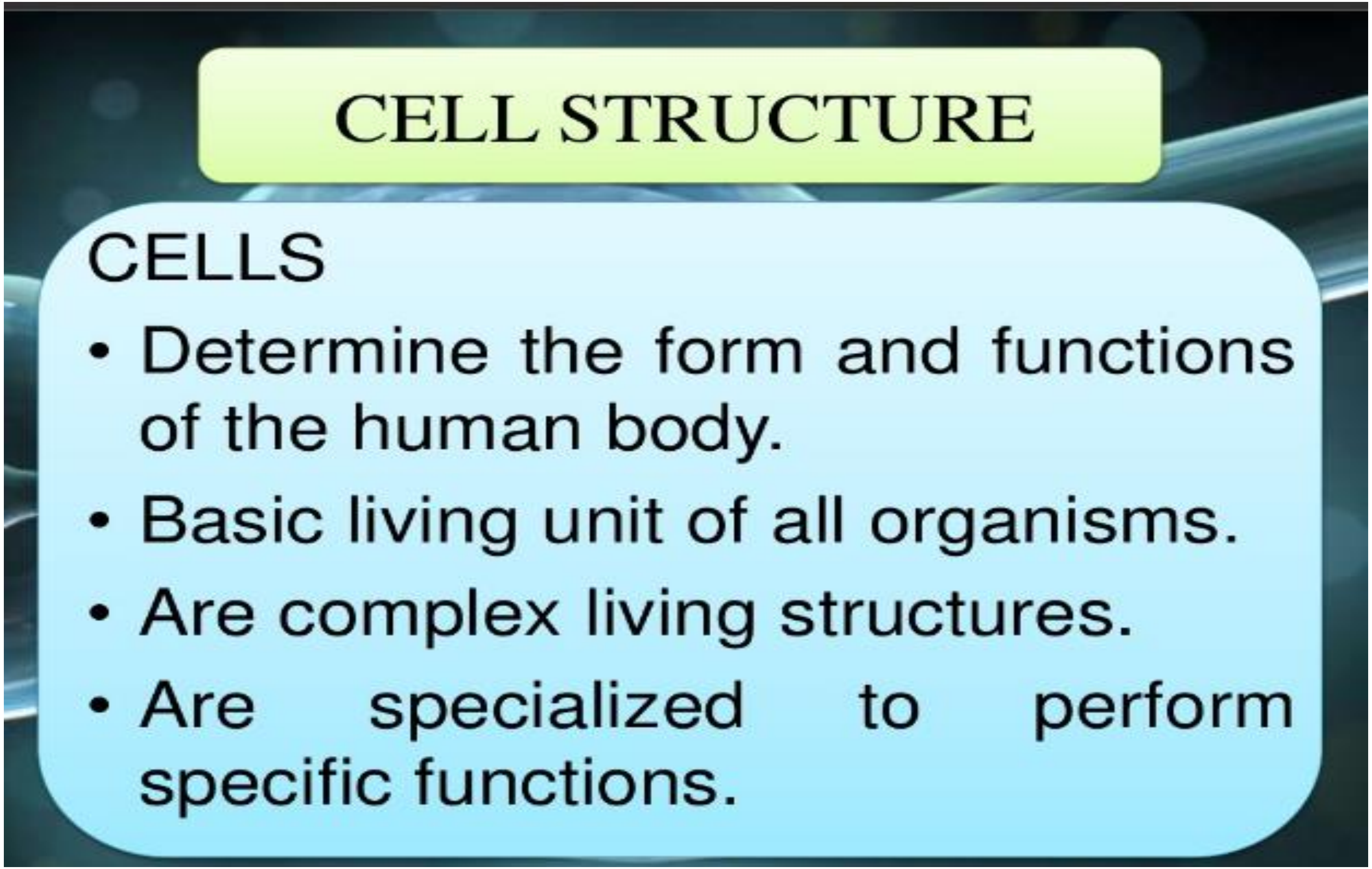
(c) Domain Eukarya

▲ **Kingdom Plantae** consists of terrestrial multicellular eukaryotes (land plants) that carry out photosynthesis, the conversion of light energy to the chemical energy in food.

► **Kingdom Fungi** is defined in part by the nutritional mode of its members (such as this mushroom), which absorb nutrients from outside their bodies.

◄ **Kingdom Animalia** consists of multicellular eukaryotes that ingest other organisms.

► **Protists** are mostly unicellular eukaryotes and some relatively simple multicellular relatives. Pictured here is an assortment of protists inhabiting pond water. Scientists are currently debating how to classify protists in a way that accurately reflects their evolutionary relationships.



CELL STRUCTURE

CELLS

- Determine the form and functions of the human body.
- Basic living unit of all organisms.
- Are complex living structures.
- Are specialized to perform specific functions.

Cell Theory

- All organisms are composed of cells
- All cells come only from preexisting cells (Rudolf Virchow)
- Cells are the smallest structural and functional unit of organisms
- Cells carry genetic information in the form of DNA

Robert Hooke (1665)

Antony van Leeuwenhoek (1673)

Matthias Jacob Schleiden (1838) plant

Theodor Schwann (1839) animal

Light microscope

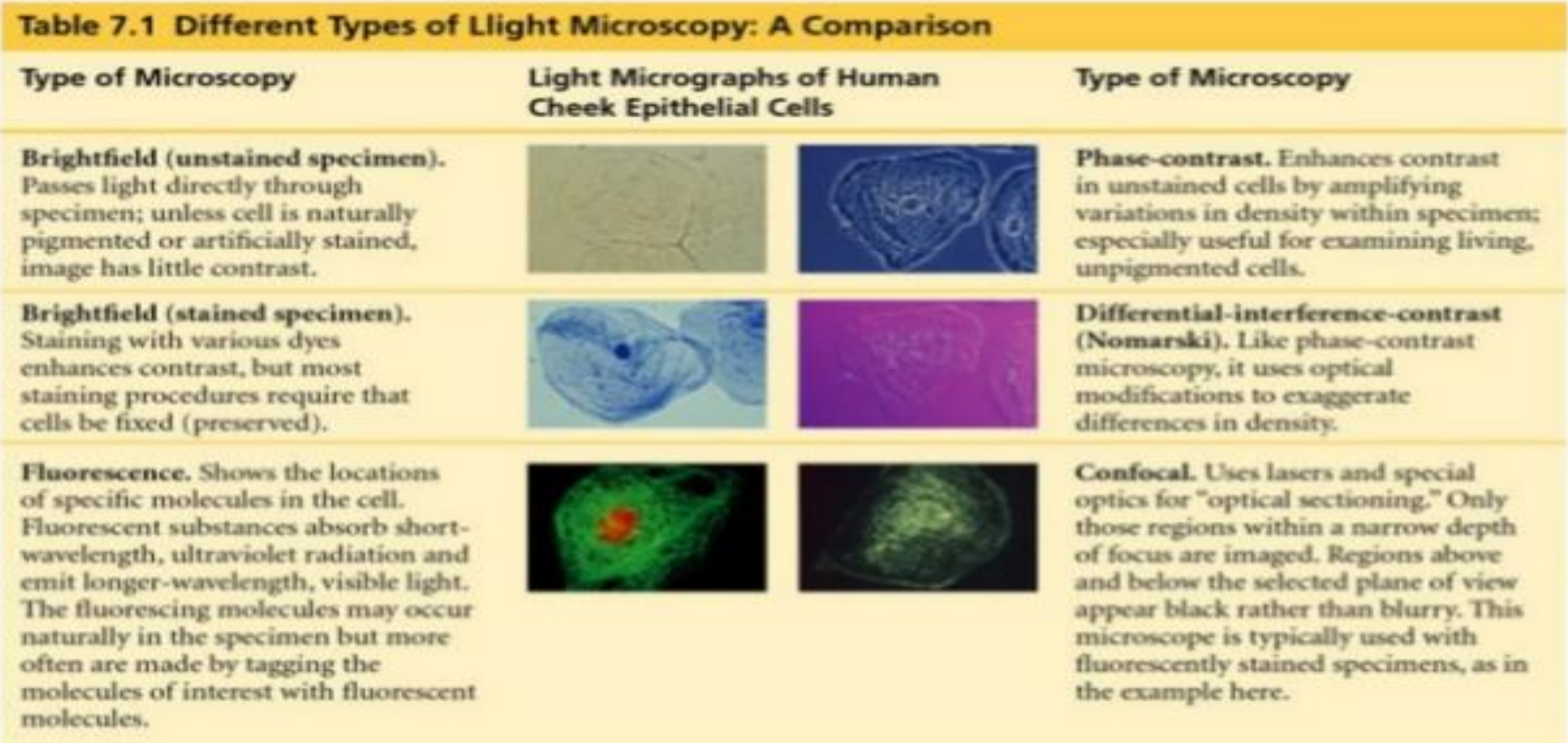


Table 7.1 Different Types of Llight Microscopy: A Comparison

Type of Microscopy	Light Micrographs of Human Cheek Epithelial Cells		Type of Microscopy
Brightfield (unstained specimen). Passes light directly through specimen; unless cell is naturally pigmented or artificially stained, image has little contrast.			**Phase-contrast.** Enhances contrast in unstained cells by amplifying variations in density within specimen; especially useful for examining living, unpigmented cells.
Brightfield (stained specimen). Staining with various dyes enhances contrast, but most staining procedures require that cells be fixed (preserved).			**Differential-interference-contrast (Nomarski).** Like phase-contrast microscopy, it uses optical modifications to exaggerate differences in density.
Fluorescence. Shows the locations of specific molecules in the cell. Fluorescent substances absorb short-wavelength, ultraviolet radiation and emit longer-wavelength, visible light. The fluorescing molecules may occur naturally in the specimen but more often are made by tagging the molecules of interest with fluorescent molecules.			**Confocal.** Uses lasers and special optics for "optical sectioning." Only those regions within a narrow depth of focus are imaged. Regions above and below the selected plane of view appear black rather than blurry. This microscope is typically used with fluorescently stained specimens, as in the example here.

Janssen Compound Microscope (circa Early 1600s)

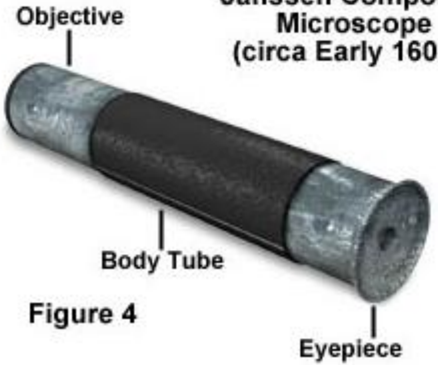


Figure 4

Von Leeuwenhoek Microscope (circa Late 1600s)

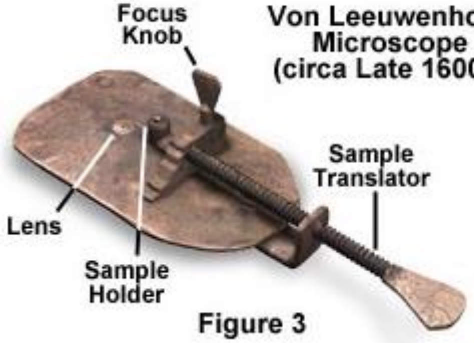


Figure 3

Powell & Lealand No. 1 circa 1850

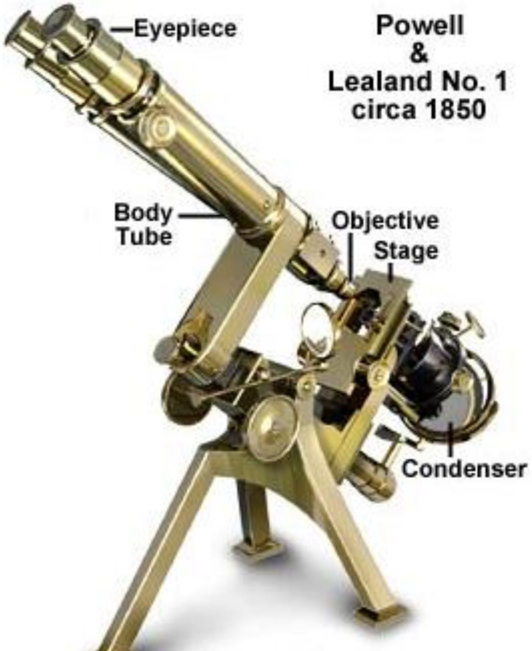


Figure 5

Hooke Microscope circa 1670

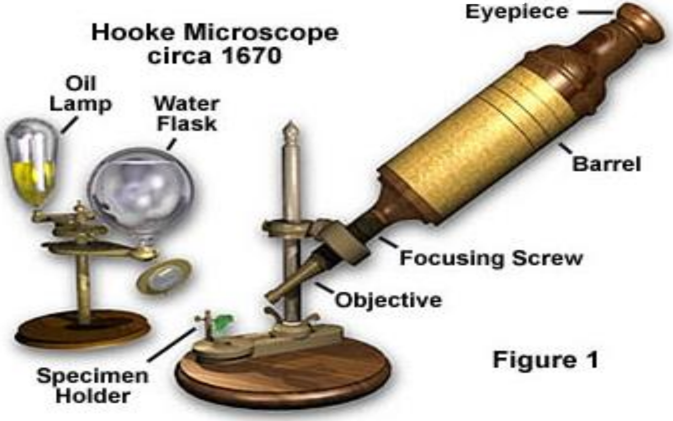


Figure 1

Zeiss Laboratory Microscope circa 1930s

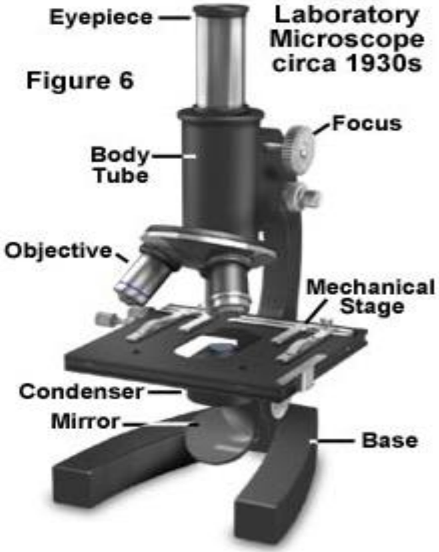


Figure 6

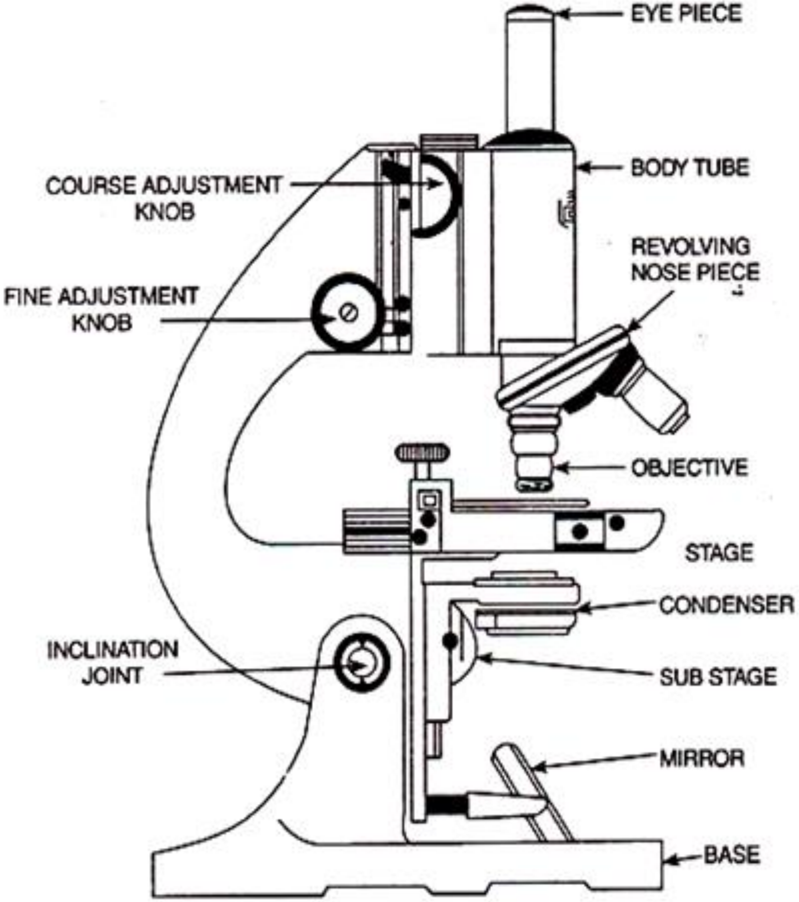
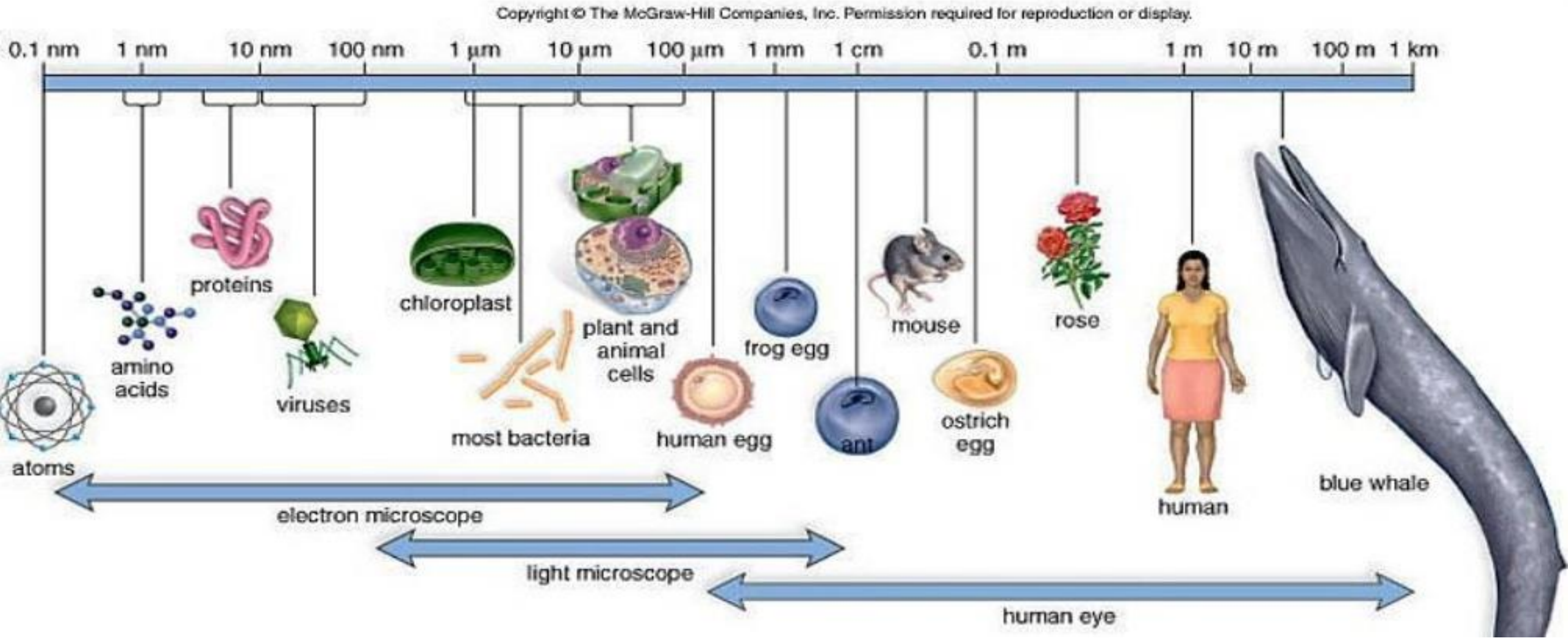


FIG. 15.1. The compound microscope showing its various parts.

Electron microscope

- To resolve smaller structures we use EM, which focuses a beam of electrons through the specimen (TEM) or onto its surface (SEM).
- TEM are used to study the internal ultrastructure of cells.
- A TEM aims an electron beam through a thin section of the specimen.
    - The image is focused and magnified by electromagnets.
    - To enhance contrast, the thin sections are stained with atoms of heavy metals.
- SEM are useful for studying surface structures.
- The SEM has great depth of field, resulting in an image that seems three-dimensional.

Sizes of Living Things



Prokaryotic and eukaryotic cells

- All cells
  - surrounded by a plasma membrane.
  - have cytosol, containing the organelles.
  - contain chromosomes
  - have ribosomes
- A major difference
  - eukaryotic cell: chromosomes are contained in the nucleus (within a membranous nuclear envelope)
  - prokaryotic cell: the DNA is concentrated in the nucleoid.

A major difference...

- Cytoplasm
  - All the material within the plasma membrane of a prokaryotic cell is cytoplasm.
  - Within the cytoplasm of a eukaryotic cell is a variety of membrane-bounded organelles of specialized form and function.
- Eukaryotic cells are generally much bigger than prokaryotic cells.
  - Smallest bacteria, mycoplasma's, are 0.1 to 1.0 micron. (most bacteria: 1-10 microns)
  - Eukaryotic cells are typically 10-100 microns in diameter

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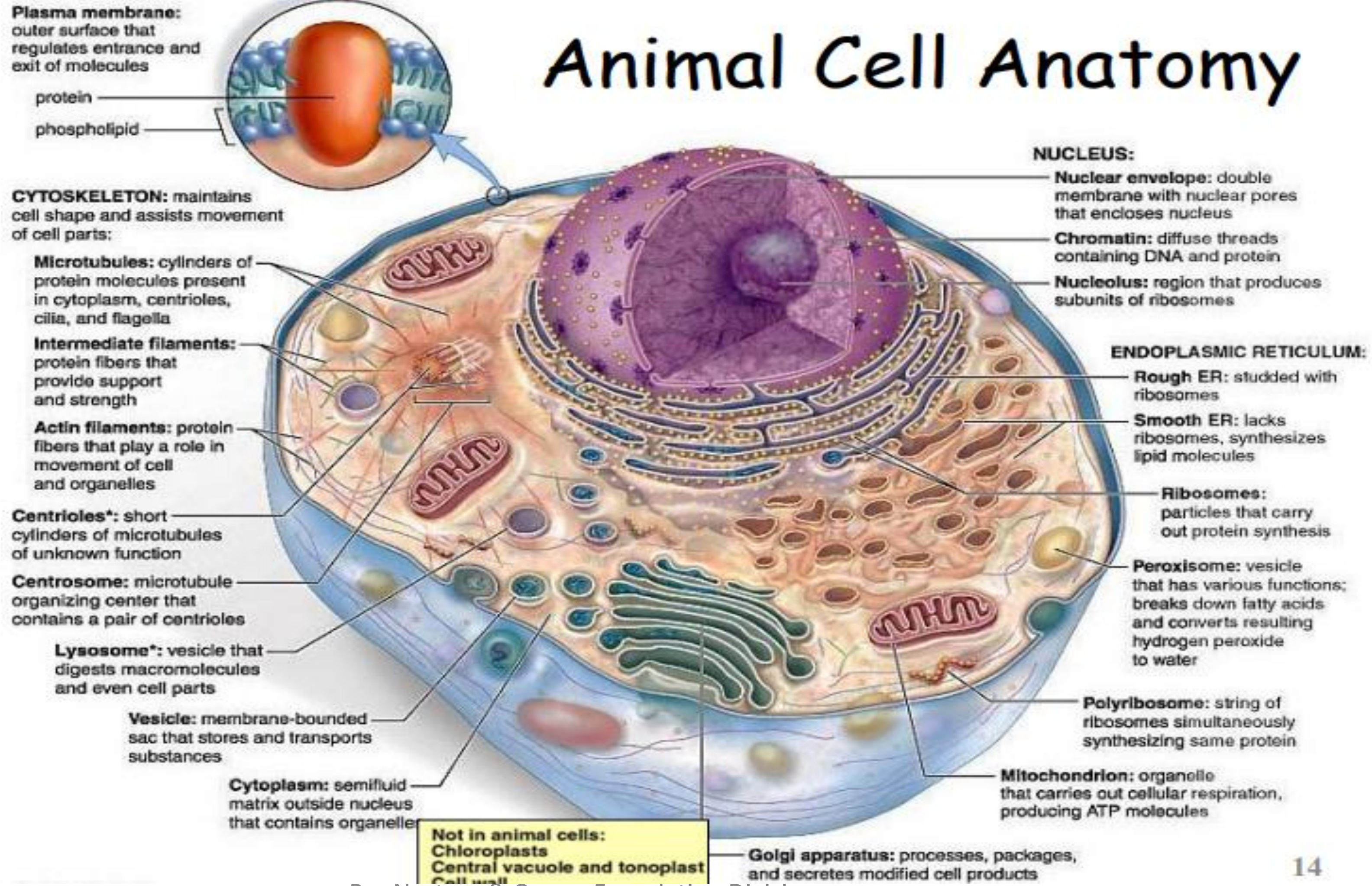
Mumbai, Maharashtra

Animal Cell Anatomy



Plasma membrane: outer surface that regulates entrance and exit of molecules

protein

phospholipid

CYTOSKELETON: maintains cell shape and assists movement of cell parts:

Microtubules: cylinders of protein molecules present in cytoplasm, centrioles, cilia, and flagella

Intermediate filaments: protein fibers that provide support and strength

Actin filaments: protein fibers that play a role in movement of cell and organelles

Centrioles*: short cylinders of microtubules of unknown function

Centrosome: microtubule organizing center that contains a pair of centrioles

Lysosome*: vesicle that digests macromolecules and even cell parts

Vesicle: membrane-bounded sac that stores and transports substances

Cytoplasm: semifluid matrix outside nucleus that contains organelles

Not in animal cells:
Chloroplasts
Central vacuole and tonoplast
Cell wall

NUCLEUS:

Nuclear envelope: double membrane with nuclear pores that encloses nucleus

Chromatin: diffuse threads containing DNA and protein

Nucleolus: region that produces subunits of ribosomes

ENDOPLASMIC RETICULUM:

Rough ER: studded with ribosomes

Smooth ER: lacks ribosomes, synthesizes lipid molecules

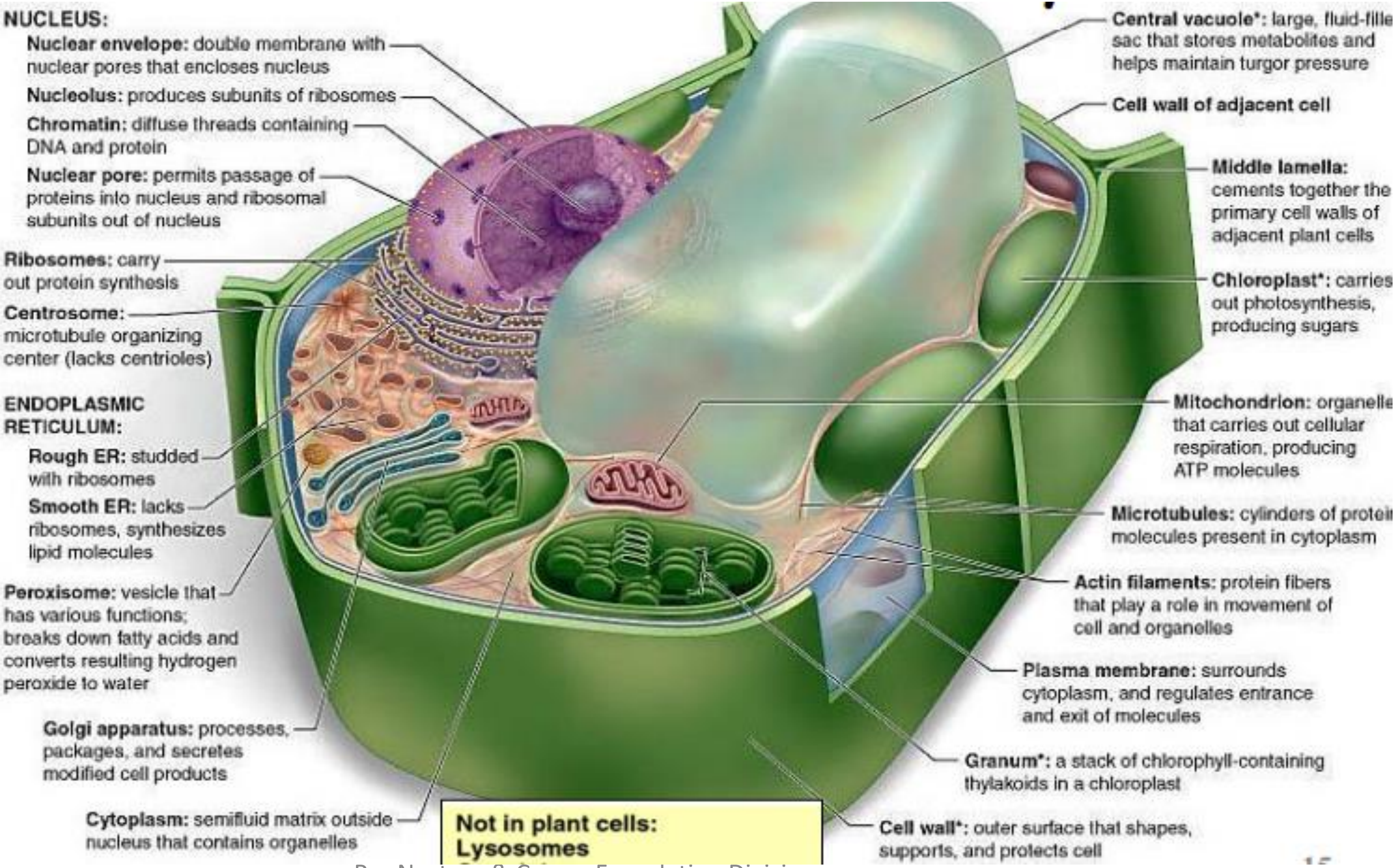
Ribosomes: particles that carry out protein synthesis

Peroxisome: vesicle that has various functions; breaks down fatty acids and converts resulting hydrogen peroxide to water

Polyribosome: string of ribosomes simultaneously synthesizing same protein

Mitochondrion: organelle that carries out cellular respiration, producing ATP molecules

Golgi apparatus: processes, packages, and secretes modified cell products



NUCLEUS:

Nuclear envelope: double membrane with nuclear pores that encloses nucleus

Nucleolus: produces subunits of ribosomes

Chromatin: diffuse threads containing DNA and protein

Nuclear pore: permits passage of proteins into nucleus and ribosomal subunits out of nucleus

Ribosomes: carry out protein synthesis

Centrosome: microtubule organizing center (lacks centrioles)

ENDOPLASMIC RETICULUM:

Rough ER: studded with ribosomes

Smooth ER: lacks ribosomes, synthesizes lipid molecules

Peroxisome: vesicle that has various functions; breaks down fatty acids and converts resulting hydrogen peroxide to water

Golgi apparatus: processes, packages, and secretes modified cell products

Cytoplasm: semifluid matrix outside nucleus that contains organelles

Central vacuole*: large, fluid-fille sac that stores metabolites and helps maintain turgor pressure

Cell wall of adjacent cell

Middle lamella: cements together the primary cell walls of adjacent plant cells

Chloroplast*: carries out photosynthesis, producing sugars

Mitochondrion: organelle that carries out cellular respiration, producing ATP molecules

Microtubules: cylinders of protei molecules present in cytoplasm

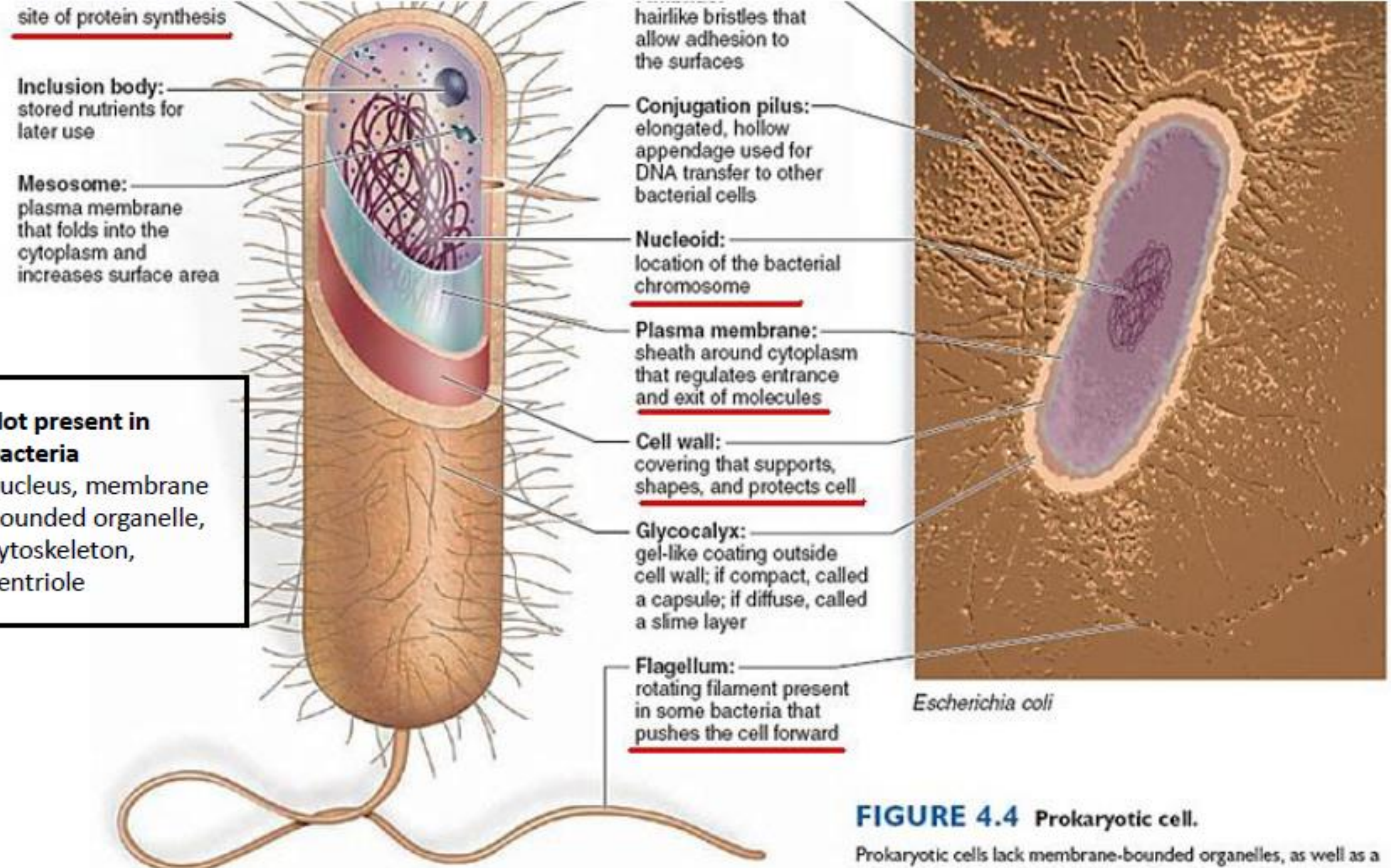
Actin filaments: protein fibers that play a role in movement of cell and organelles

Plasma membrane: surrounds cytoplasm, and regulates entrance and exit of molecules

Granum*: a stack of chlorophyll-containing thylakoids in a chloroplast

Cell wall*: outer surface that shapes, supports, and protects cell

Not in plant cells:
Lysosomes



site of protein synthesis

Inclusion body: stored nutrients for later use

Mesosome: plasma membrane that folds into the cytoplasm and increases surface area

hairlike bristles that allow adhesion to the surfaces

Conjugation pilus: elongated, hollow appendage used for DNA transfer to other bacterial cells

Nucleoid: location of the bacterial chromosome

Plasma membrane: sheath around cytoplasm that regulates entrance and exit of molecules

Cell wall: covering that supports, shapes, and protects cell

Glycocalyx: gel-like coating outside cell wall; if compact, called a capsule; if diffuse, called a slime layer

Flagellum: rotating filament present in some bacteria that pushes the cell forward

Escherichia coli

Not present in bacteria
nucleus, membrane bounded organelle, cytoskeleton, centriole

FIGURE 4.4 **Prokaryotic cell.**

Prokaryotic cells lack membrane-bounded organelles, as well as a nucleus. Their DNA is located in a region called a nucleoid.

Eukaryotic Cells	Prokaryotic Cells
"complex" organisms, including all plants, protists, fungi and animals	"Simple" organisms, including bacteria and cyanobacteria
Contain nucleus and membrane bound organelles	Lack nucleus and other membrane-encased organelles.
Several chromosome	Single chromosome (DNA + non-histone protein)
Can specialize for certain functions, multicellular organs and organisms	Usually exist as single, virtually identical cells
Cellular respiration occur in mitochondria	Cellular respiration occur in mesosome (extended membrane)
Ribosome: 40s, 60S	Ribosome: 30S, 50S
Photosynthesis occur in chloroplast	Photosynthesis occur in chlorophyll located region
Cell Wall present in Plants & Fungi only	Cell Wall

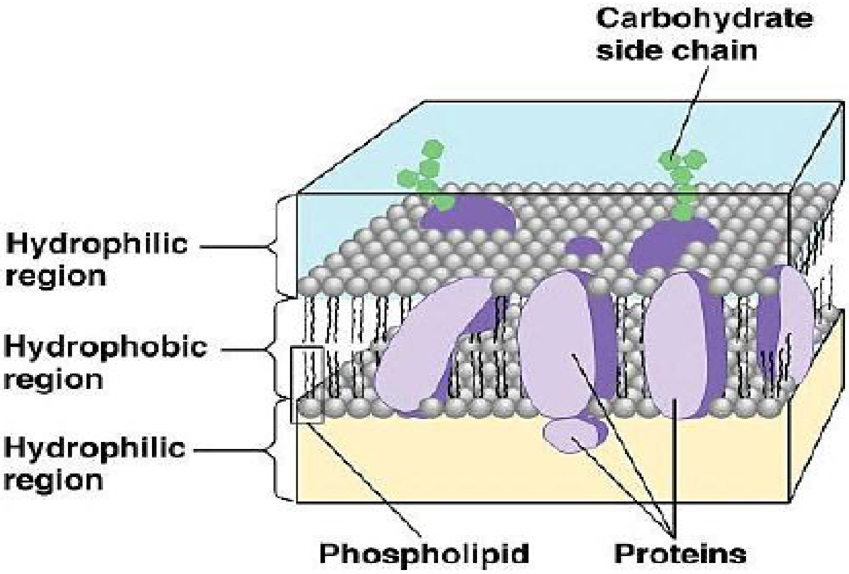
Cyanobacteria (blue-green algae) e.g. *Nostoc, Oscillatoria, Anabaena, Spirulina*

Cells

- Cell coat: Cell wall, Cell membrane
- Protoplasm
  - Nucleus : nuclear membrane, nucleoplasm (chromatin fiber, nucleolus)
  - Cytoplasm
    - cytosol
    - organelle
      - no membrane bounded: ribosome, centriole, cytoskeleton
      - single membrane bounded: ER, Golgi complex, lysosome, peroxisome, vacuole
      - double membrane bounded: mitochondria, chloroplast

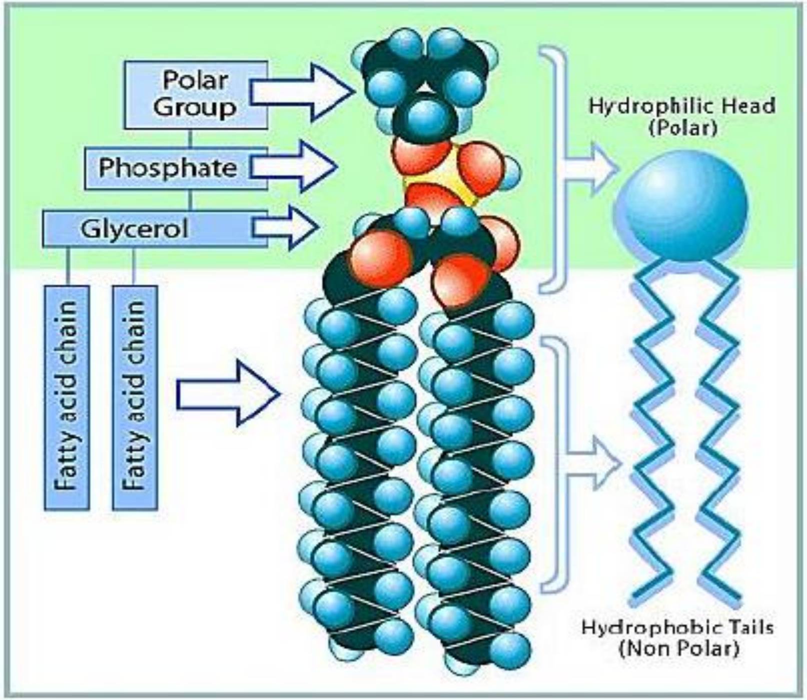
Plasma membrane

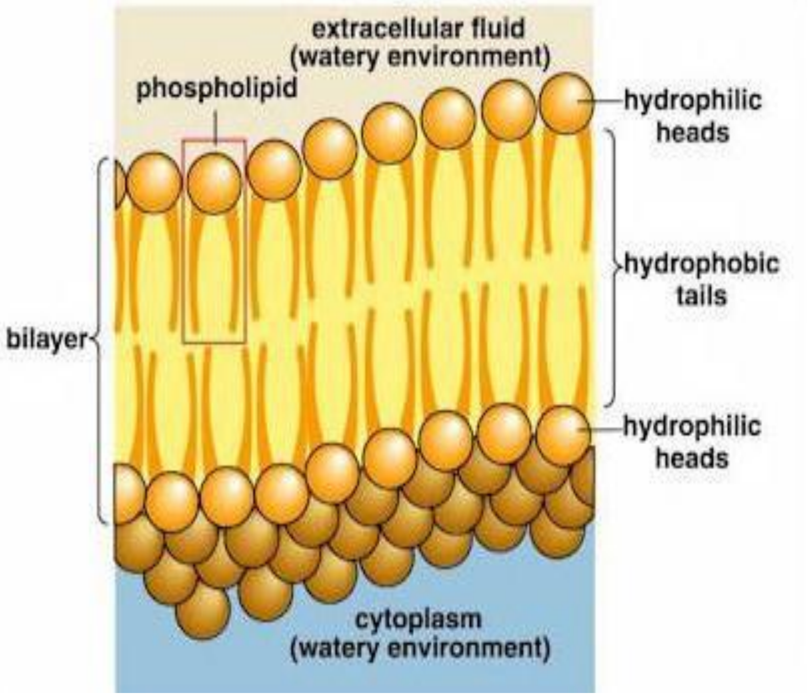
- Fluid mosaic model
  - Phospholipid bilayer acts more like a fluid than a liquid
- Contains integral and peripheral proteins
- Semi permeable membrane
- Like a city border they surround the cell and are able to regulate entrance and exit



(b) Structure of the plasma membrane

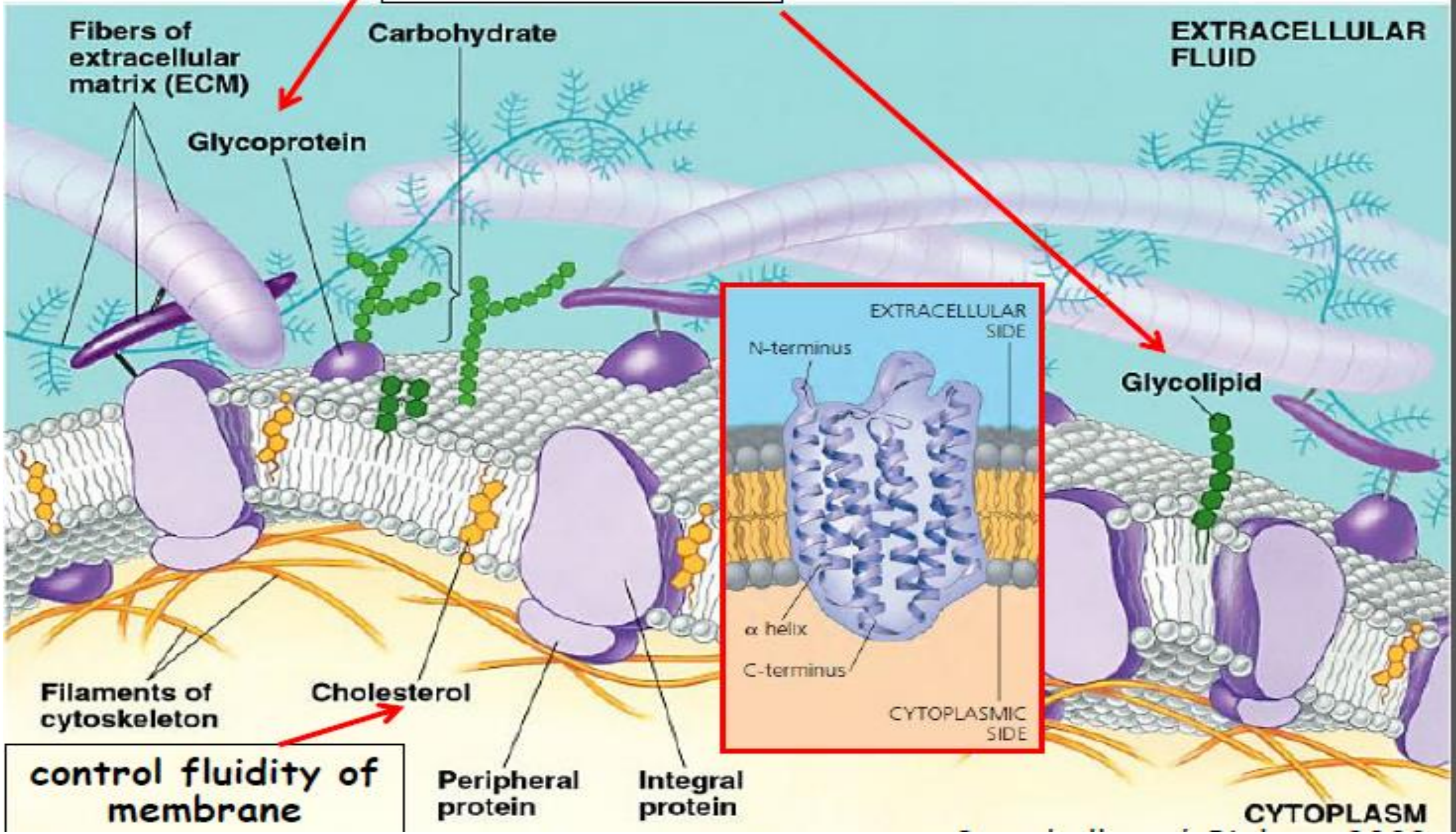
Phospholipid bilayer




extracellular fluid (watery environment)
phospholipid
hydrophilic heads
bilayer
hydrophobic tails
hydrophilic heads
cytoplasm (watery environment)

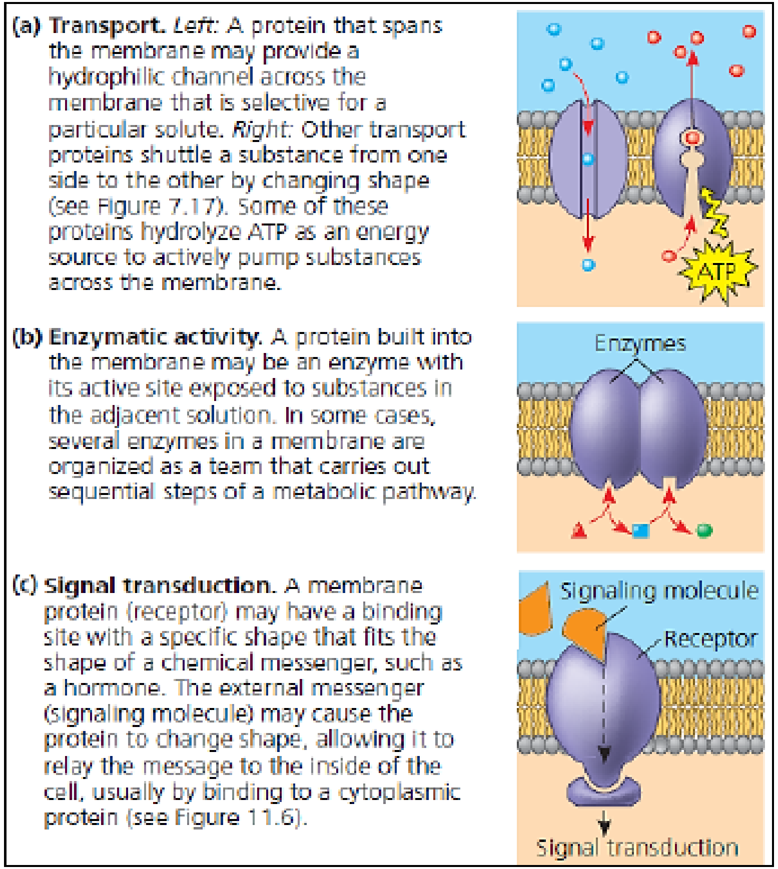
- ▪polar heads face outward towards the watery environments both inside and outside the cell .
- ▪non polar tails face inward away from the watery environment .

recognition of cell



control fluidity of membrane

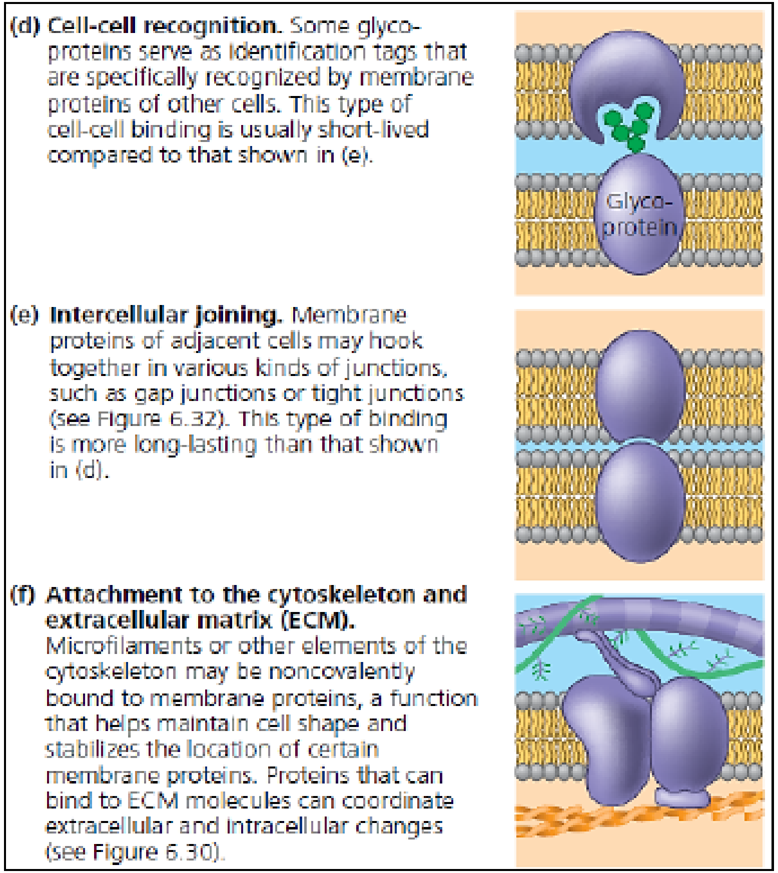
Function of membrane protein



(a) Transport. *Left:* A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute. *Right:* Other transport proteins shuttle a substance from one side to the other by changing shape (see Figure 7.17). Some of these proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.

(b) Enzymatic activity. A protein built into the membrane may be an enzyme with its active site exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane are organized as a team that carries out sequential steps of a metabolic pathway.

(c) Signal transduction. A membrane protein (receptor) may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external messenger (signaling molecule) may cause the protein to change shape, allowing it to relay the message to the inside of the cell, usually by binding to a cytoplasmic protein (see Figure 11.6).

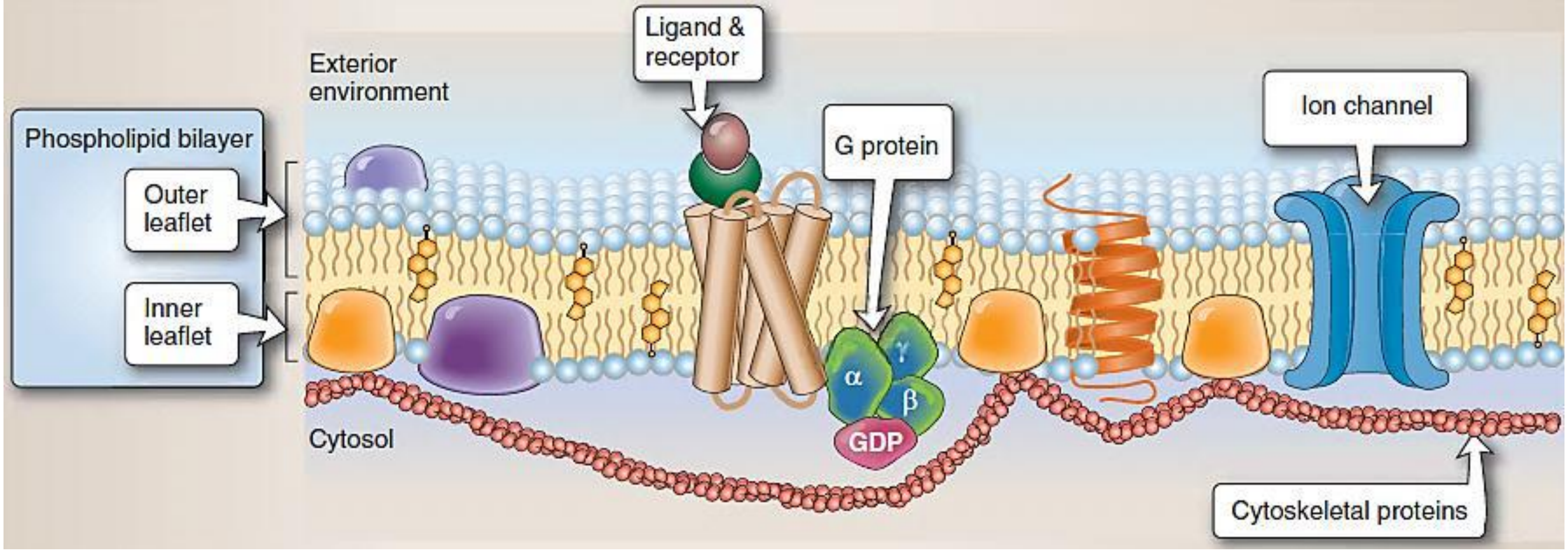


(d) Cell-cell recognition. Some glycoproteins serve as identification tags that are specifically recognized by membrane proteins of other cells. This type of cell-cell binding is usually short-lived compared to that shown in (e).

(e) Intercellular joining. Membrane proteins of adjacent cells may hook together in various kinds of junctions, such as gap junctions or tight junctions (see Figure 6.32). This type of binding is more long-lasting than that shown in (d).

(f) Attachment to the cytoskeleton and extracellular matrix (ECM). Microfilaments or other elements of the cytoskeleton may be noncovalently bound to membrane proteins, a function that helps maintain cell shape and stabilizes the location of certain membrane proteins. Proteins that can bind to ECM molecules can coordinate extracellular and intracellular changes (see Figure 6.30).

Function of membrane protein

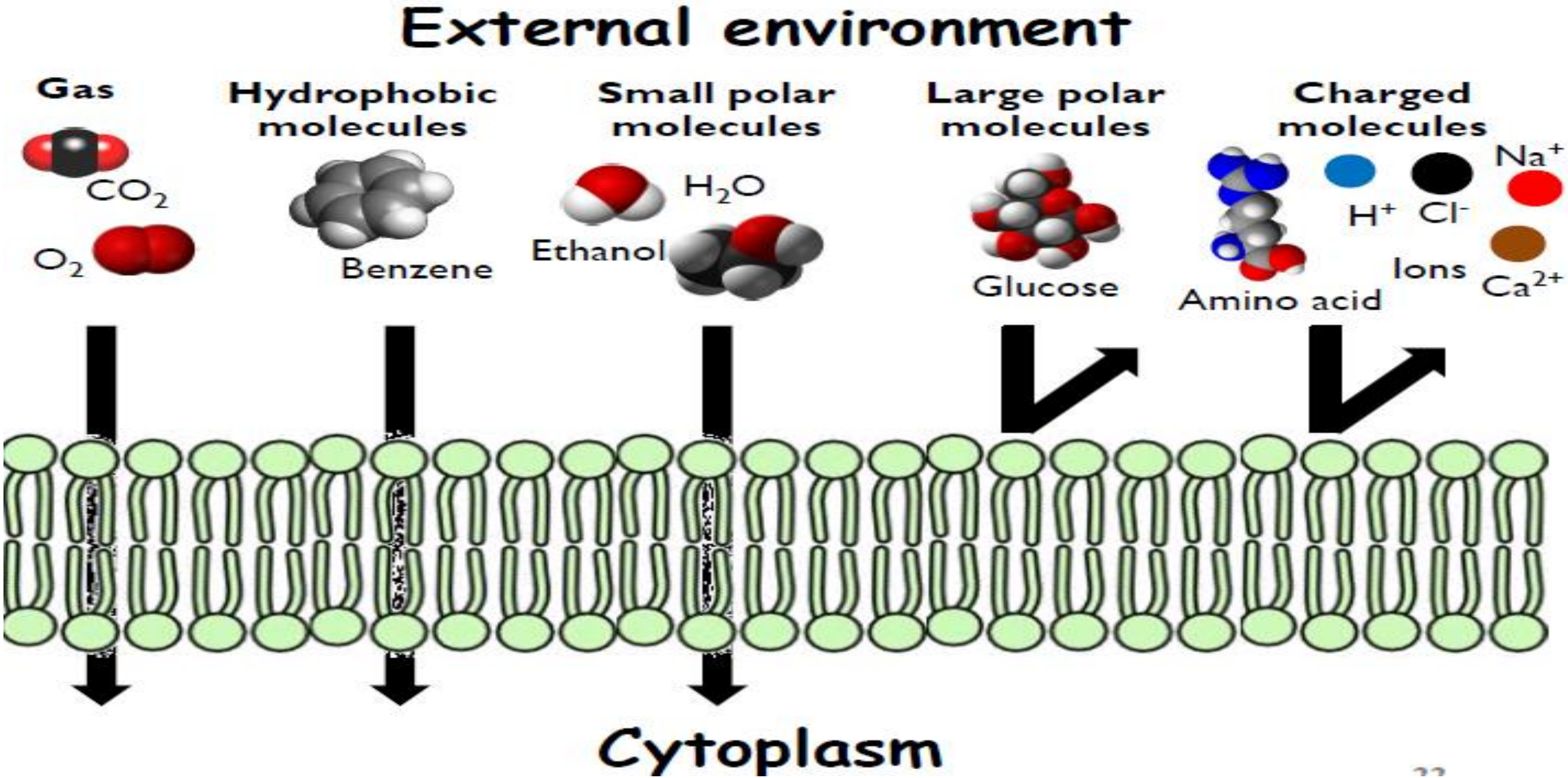


Enzyme

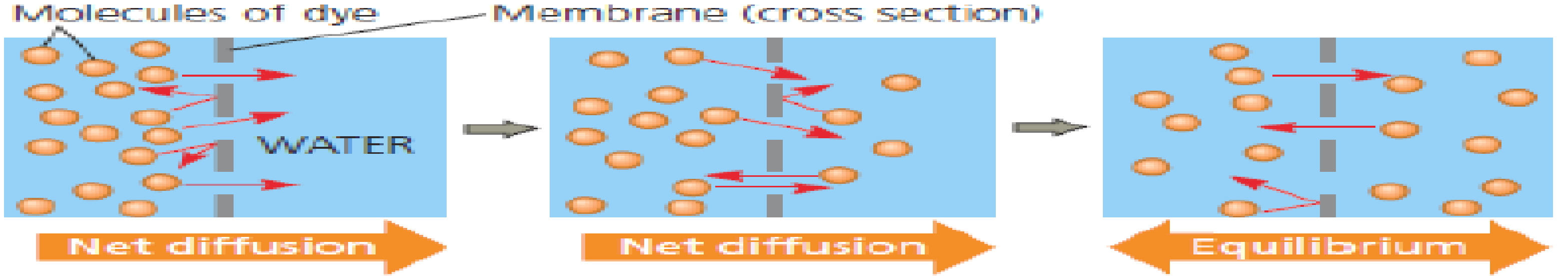
- Mediate the passage of ions and most biological molecule
- Selective traffic of molecule
- Control the interactions between cells of multicellular organisms
- Serve as sensor (e.g. receptors, signal transductions)

Transport through membrane

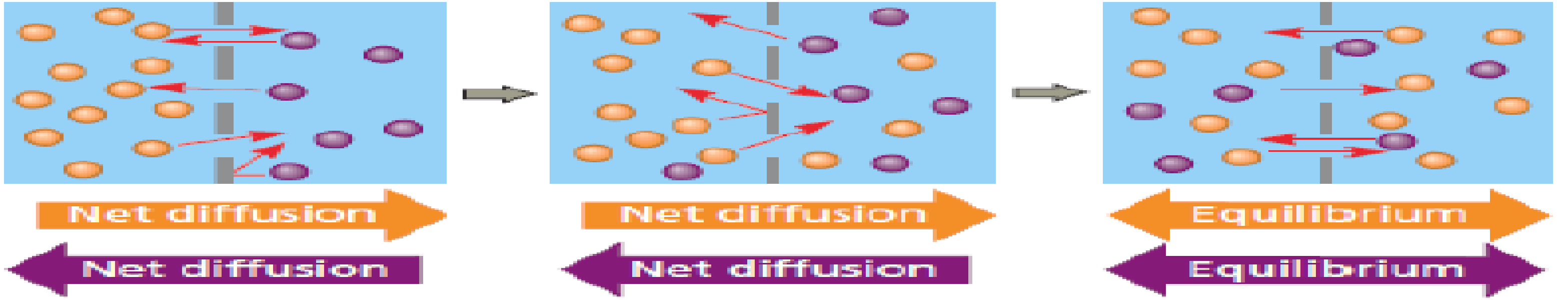
- Passive transport: need no energy, downhill
  - simple diffusion
  - facilitated diffusion: channel protein, carrier protein
- Active transport: need energy, uphill
  - primary active : direct hydrolysis of ATP
  - secondary active : symporters, antiporters
- Vesicle transport
  - endocytosis: receptor mediated, phagocytosis, pinocytosis
  - exocytosis


External environment
Gas
CO_2
O_2
Hydrophobic molecules
Benzene
Small polar molecules
H_2O
Ethanol
Large polar molecules
Glucose
Charged molecules
Amino acid
H^+
Cl^-
Na^+
Ions
Ca^{2+}
Cytoplasm

Diffusion

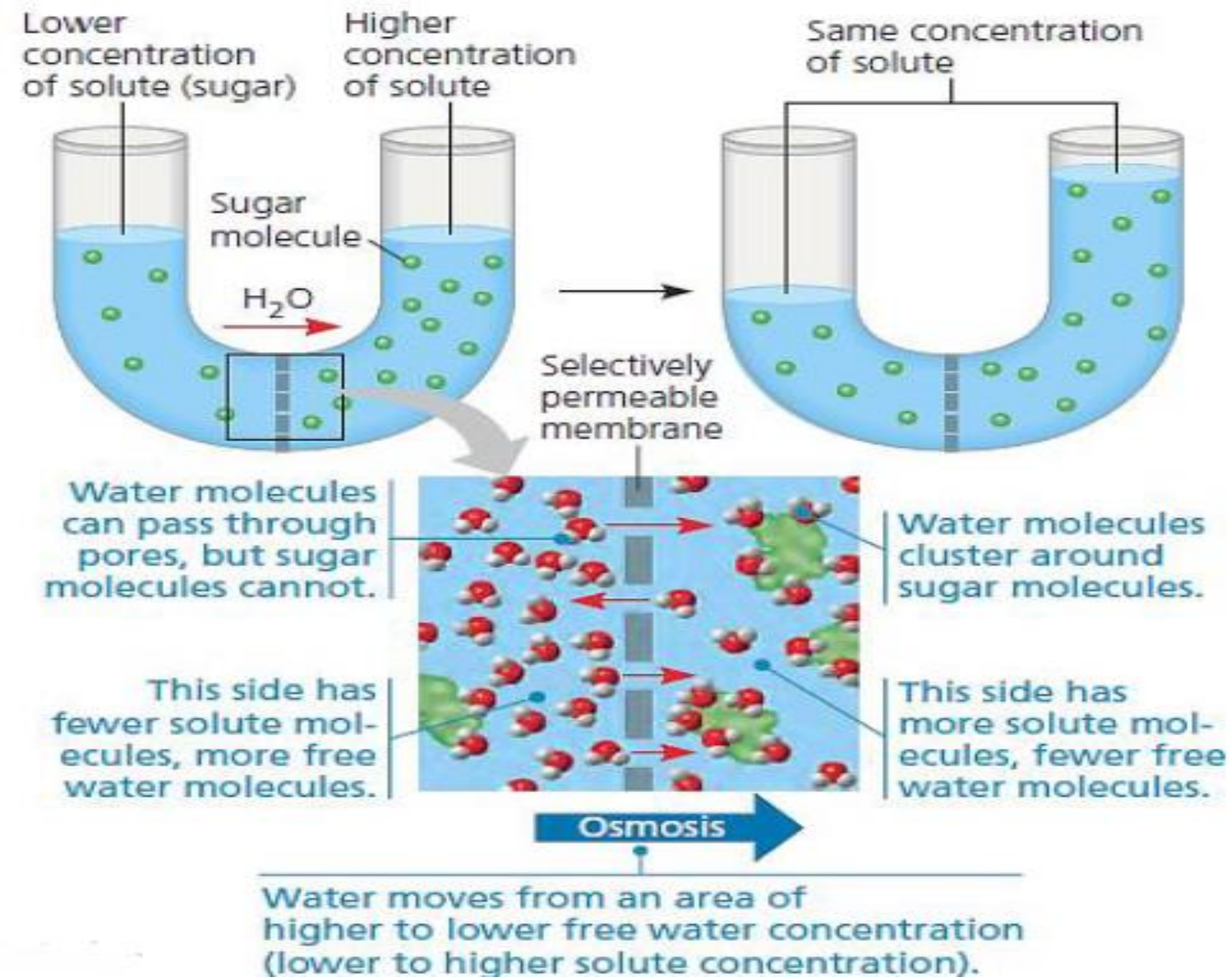


(a) Diffusion of one solute. The membrane has pores large enough for molecules of dye to pass through. Random movement of dye molecules will cause some to pass through the pores; this will happen more often on the side with more dye molecules. The dye diffuses from where it is more concentrated to where it is less concentrated (called diffusing down a concentration gradient). This leads to a dynamic equilibrium: The solute molecules continue to cross the membrane, but at equal rates in both directions.

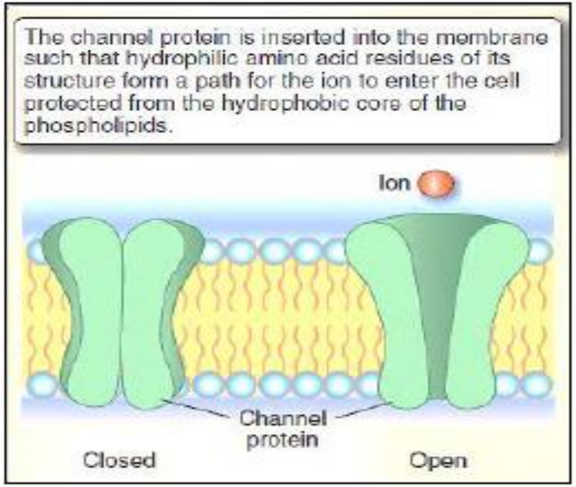


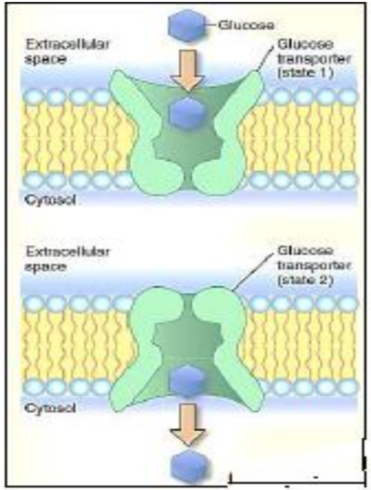
(b) Diffusion of two solutes. Solutions of two different dyes are separated by a membrane that is permeable to both. Each dye diffuses down its own concentration gradient. There will be a net diffusion of the purple dye toward the left, even though the *total* solute concentration was initially greater on the left side.

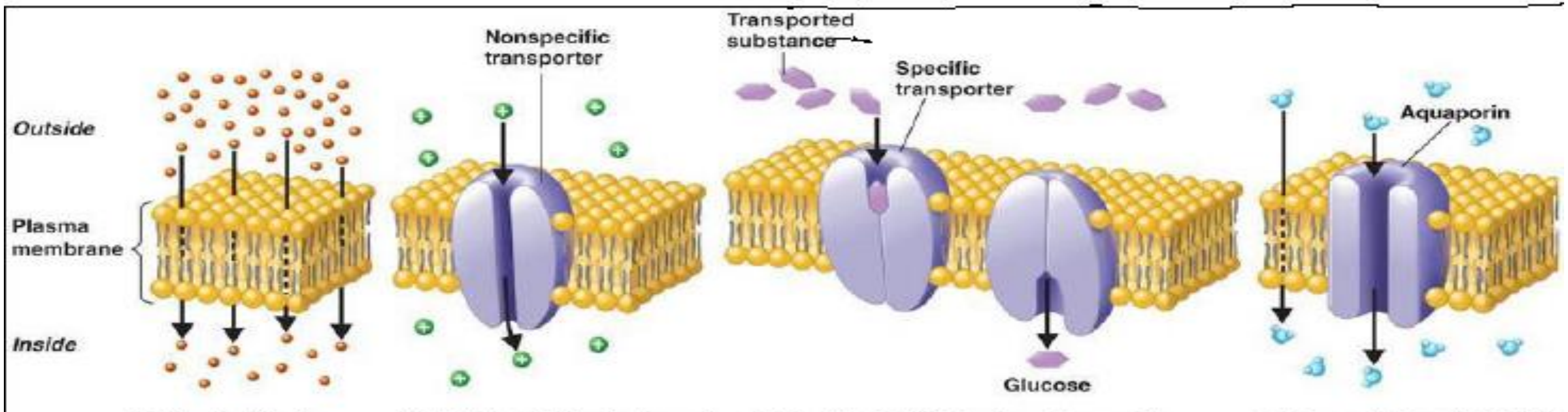
OSMOSIS


Lower concentration of solute (sugar)
Higher concentration of solute
Same concentration of solute
Sugar molecule
H_2O
Selectively permeable membrane
Water molecules can pass through pores, but sugar molecules cannot.
Water molecules cluster around sugar molecules.
This side has fewer solute molecules, more free water molecules.
This side has more solute molecules, fewer free water molecules.
Osmosis
Water moves from an area of higher to lower free water concentration (lower to higher solute concentration).

Passive transport


The channel protein is inserted into the membrane such that hydrophilic amino acid residues of its structure form a path for the ion to enter the cell protected from the hydrophobic core of the phospholipids.





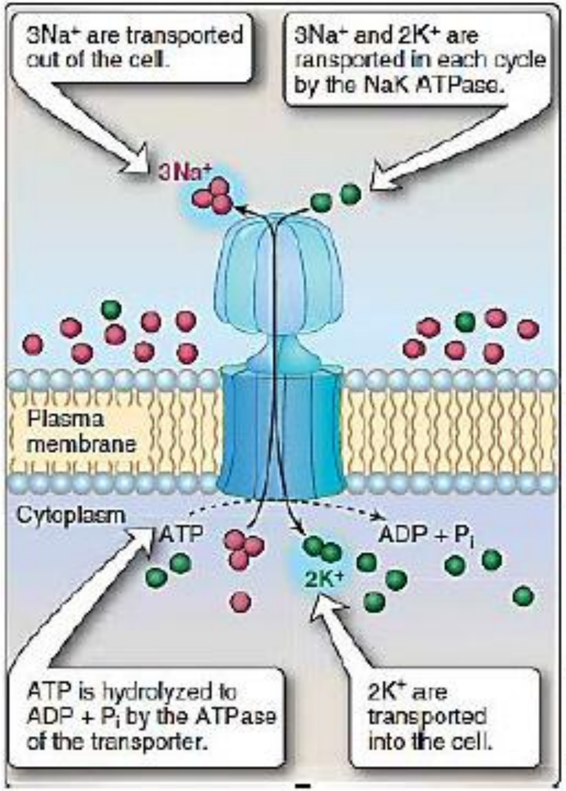
(a) Simple diffusion through the lipid bilayer

(b) Facilitated diffusion through a nonspecific transporter

(c) Facilitated diffusion through a specific transporter

(d) Osmosis through the lipid bilayer (left) and an aquaporin

Active transport

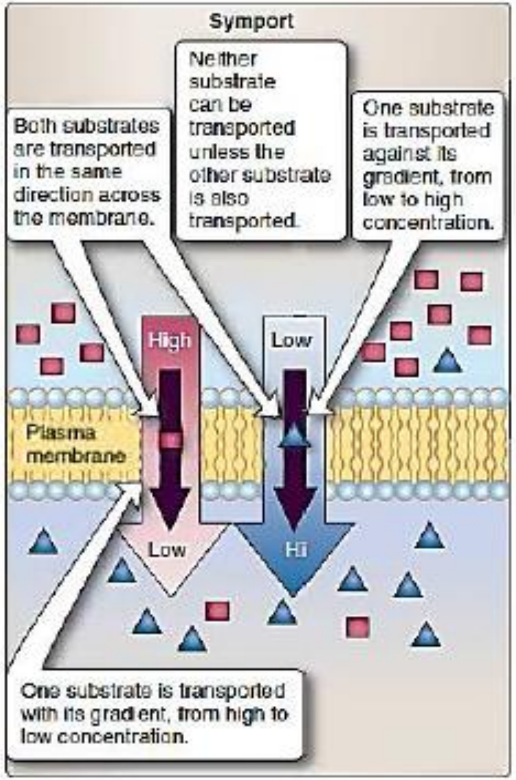


3Na⁺ are transported out of the cell.

3Na⁺ and 2K⁺ are ransported in each cycle by the NaK ATPase.

ATP is hydrolyzed to ADP + P_i by the ATPase of the transporter.

2K⁺ are transported into the cell.



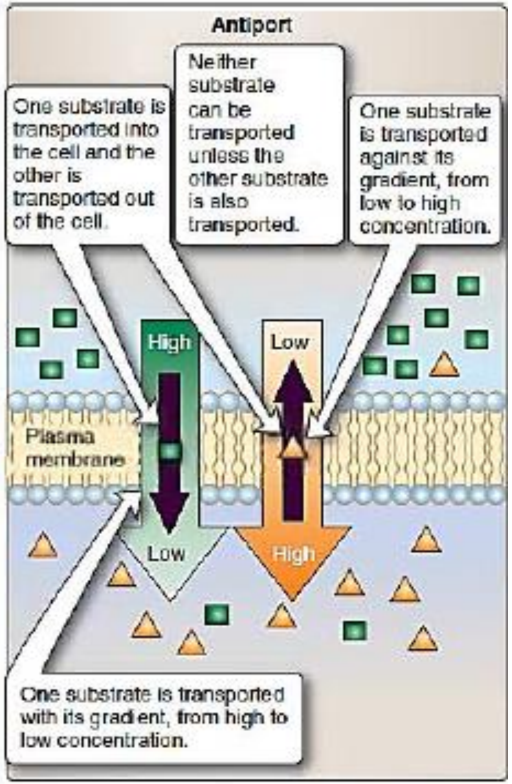
Both substrates are transported in the same direction across the membrane.

Neither substrate can be transported unless the other substrate is also transported.

One substrate is transported against its gradient, from low to high concentration.

One substrate is transported with its gradient, from high to low concentration.

Na^+-glucose transporter in intestinal epithelial cell



One substrate is transported into the cell and the other is transported out of the cell.

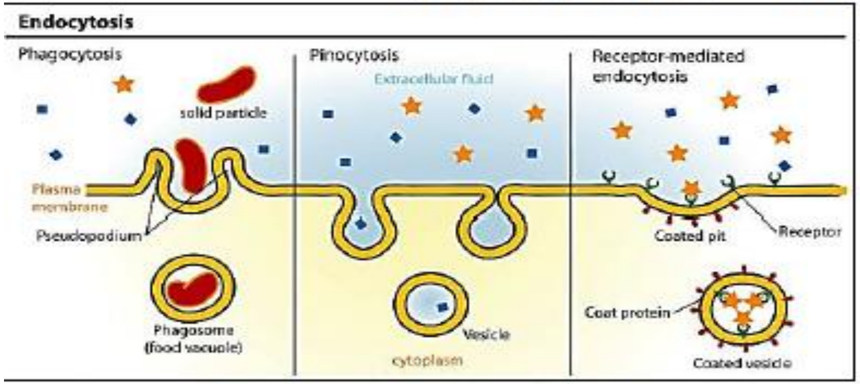
Neither substrate can be transported unless the other substrate is also transported.

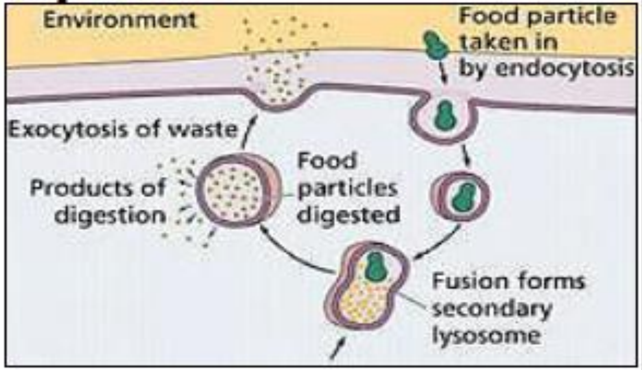
One substrate is transported against its gradient, from low to high concentration.

One substrate is transported with its gradient, from high to low concentration.

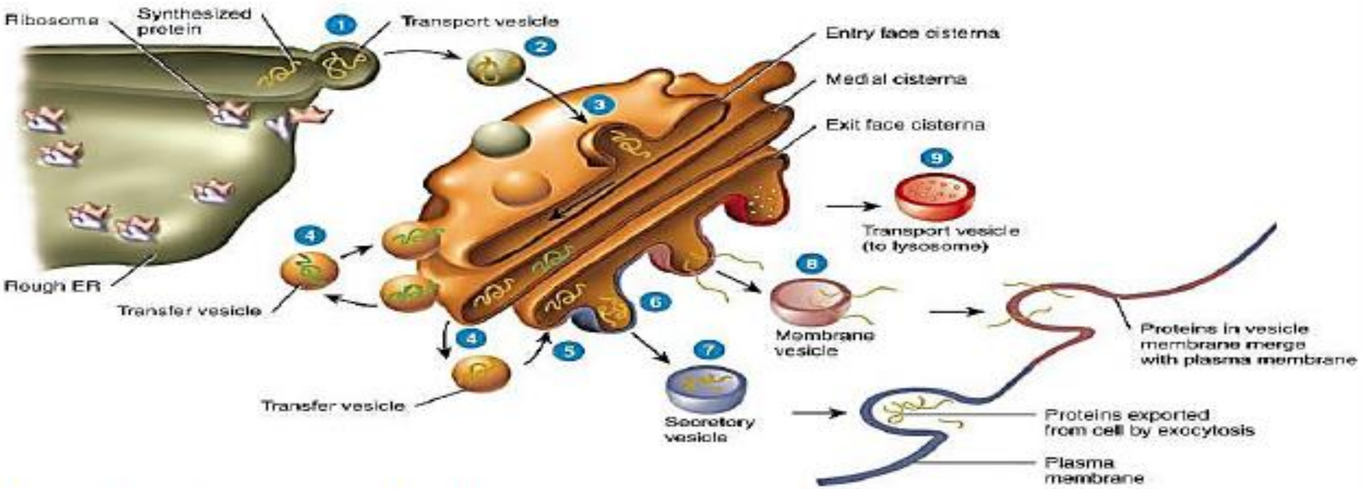
Na^+-Ca^{2+}antiporter in cardiac muscle

Vesicle Transport





All proteins exported from the cell are processed in the Golgi complex.



PLANT CELL WALL

- The plant cell wall is a remarkable structure. It provides the most significant difference between plant cells and other eukaryotic cells.
- The wall is rigid(up to many micrometers in thickness) and gives plant cells a very defined shape.
- While most cells have a outer membrane , none is comparable in strength to the plant cell wall. The cell wall is the reason for the difference between plant and animal cell functions. Because the plant has evolved this rigid structure.

COMPONENTS OF PLANT CELL WALL

- The plant cell wall composed of :
  1. The Middle Lamella
  2. The Primary Cell Wall
  3. The Secondary Cell Wall
  4. The Tertiary Cell Wall

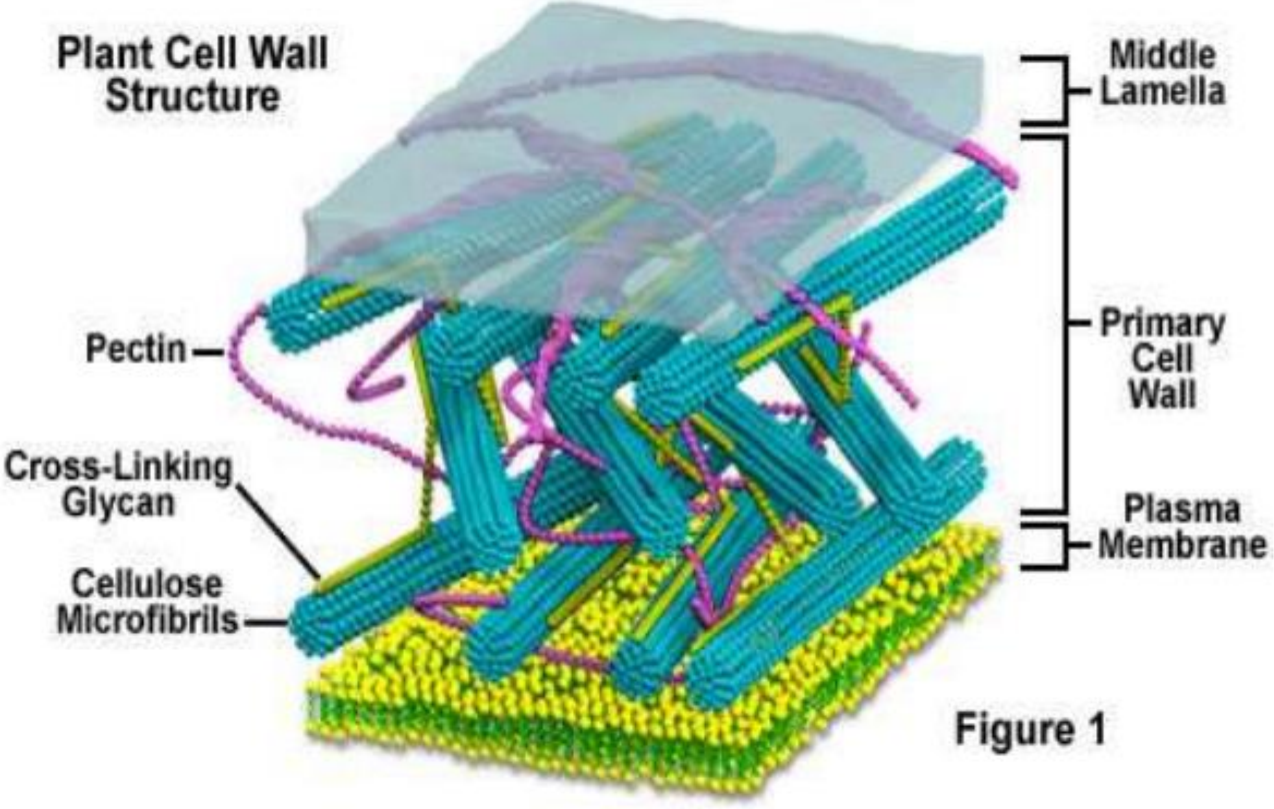
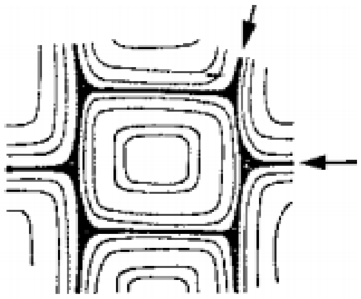

Plant Cell Wall Structure
Middle Lamella
Pectin
Primary Cell Wall
Cross-Linking Glycan
Plasma Membrane
Cellulose Microfibrils

Figure 1

1. MIDDLE LAMELLA



- It is present between two adjacent cells.
- It is situated outside primary cell wall and is made up of calcium and magnesium pectate.
- It acts as cement which holds the adjacent cells together.

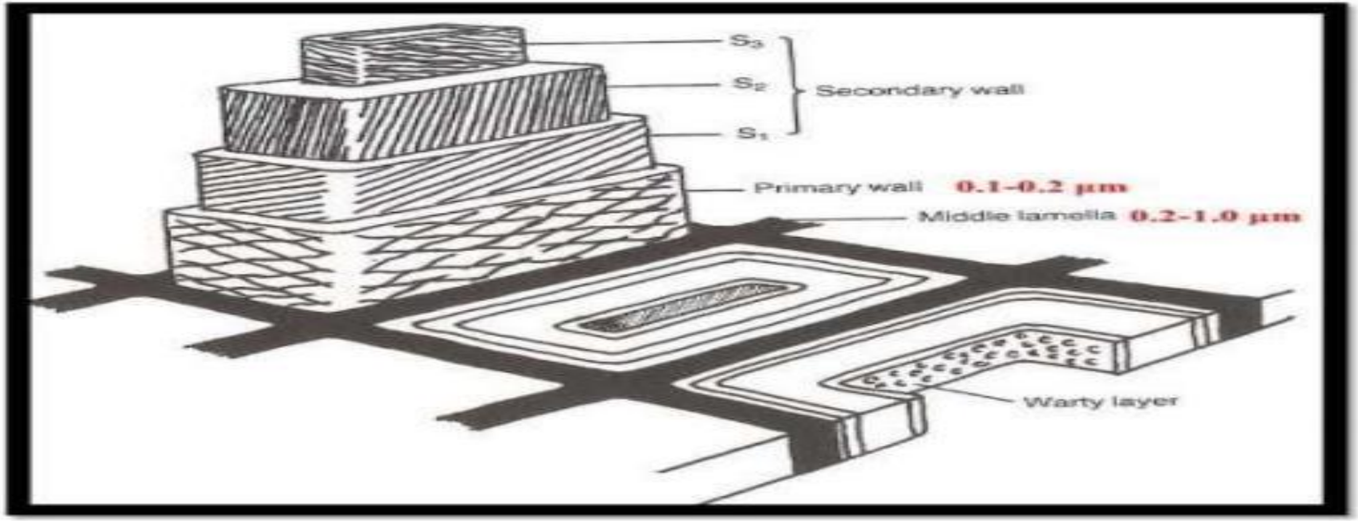
2. PRIMARY CELL WALL

- It is formed after the middle lamella.
- A thin, flexible and extensible layer.
- It is capable of growth and expansion.
- The backbone of primary cell wall is formed by the cellulose fibrils.
- The matrix is composed of hemicellulose, pectin compounds, lipids, structural proteins.

SECONDARY CELL WALL

- It is extremely rigid and provides strength.
- It is not found in all cell types.
- It consists of three layers known as S1(outer),S2(middle) and S3(inner).
- It is composed of cellulose, hemicellulose and lignin.

Structure of secondary cell wall

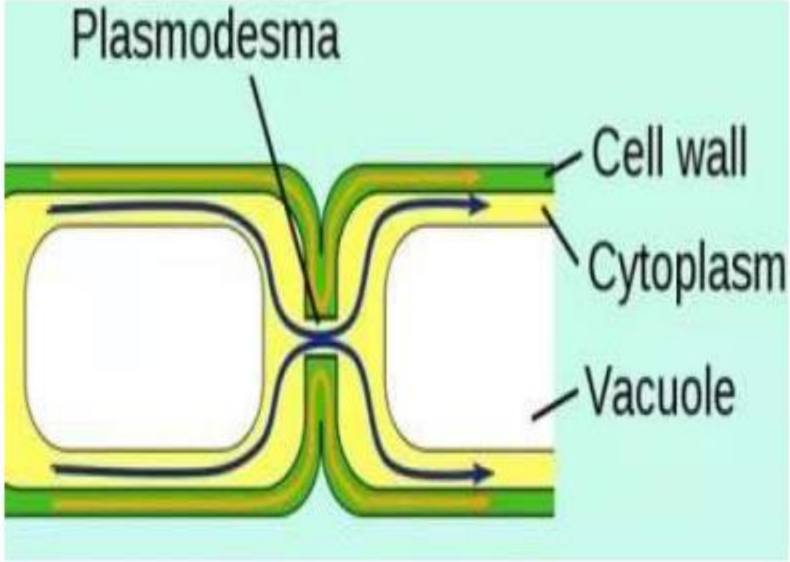


4.TERTIARY CELL WALL

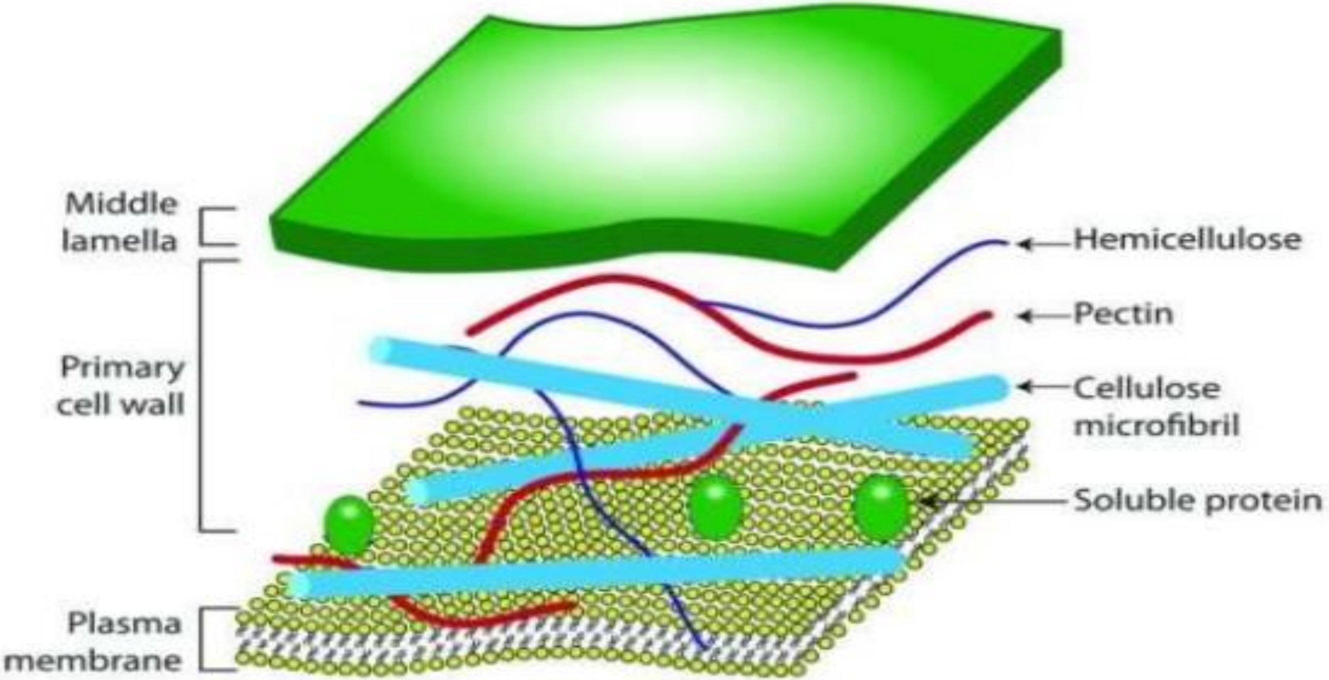
- Tertiary cell wall is deposited in few cells.
- It is considered to be dry residue of protoplast .
- Besides cellulose and hemi-cellulose, xylan is also present.

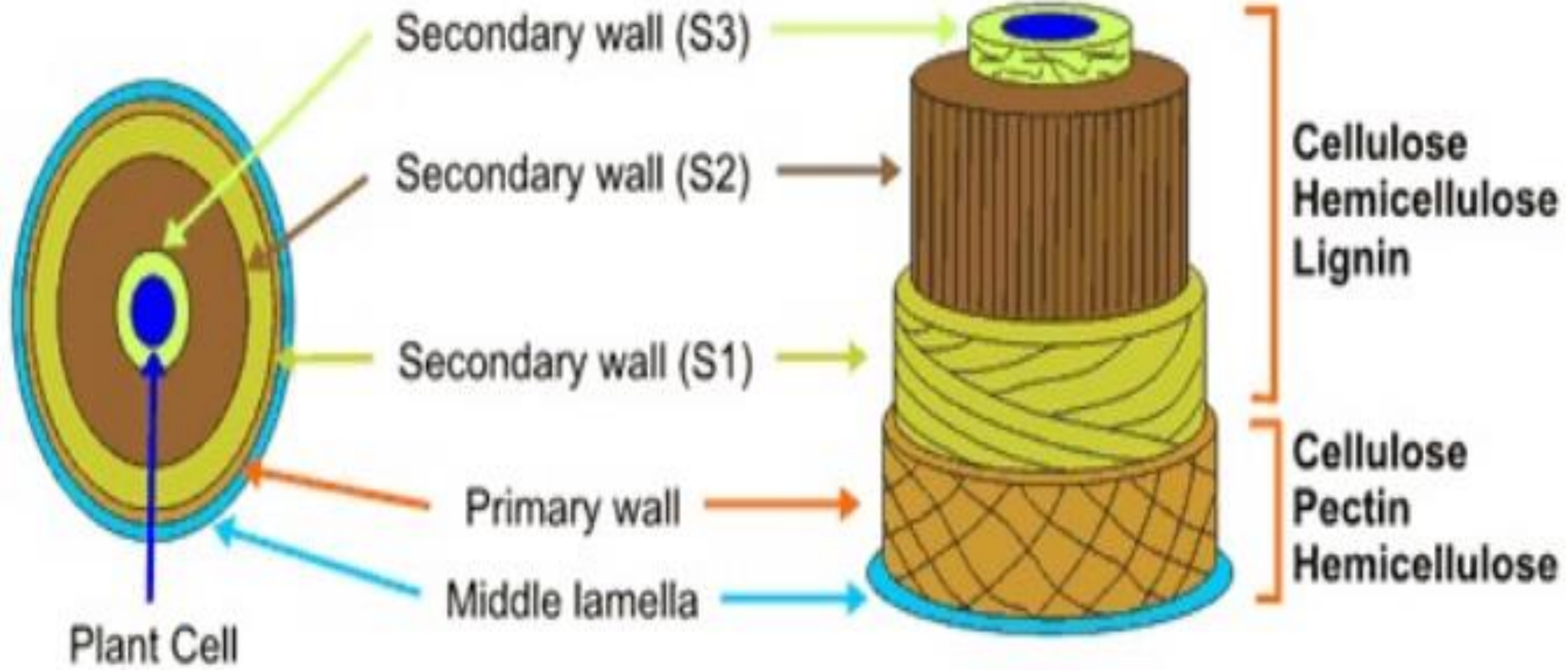
PLASMODESMATA

- Plasmodesmata are protoplasmic strands that connect the protoplasts of neighboring cells.
- Diameter is 40-50 nm.



STRUCTURE OF PRIMARY CELL WALL




Secondary wall (S3)
Secondary wall (S2)
Secondary wall (S1)
Primary wall
Middle lamella
Plant Cell
Cellulose
Hemicellulose
Lignin
Cellulose
Pectin
Hemicellulose

FUNCTIONS OF CELL WALL

- They **determine** the morphology, growth and development of plant cells.
- They **protect the protoplasm** from invasion by viral, bacterial and fungal pathogens.
- They are rigid structures and thus help the plant **in withstanding** the gravitational forces.
- They are involved in the **transport of materials** and **metabolites** into and out of cell.
- They withstand the **turgor pressure** which develops within the cells due to high osmotic pressure.

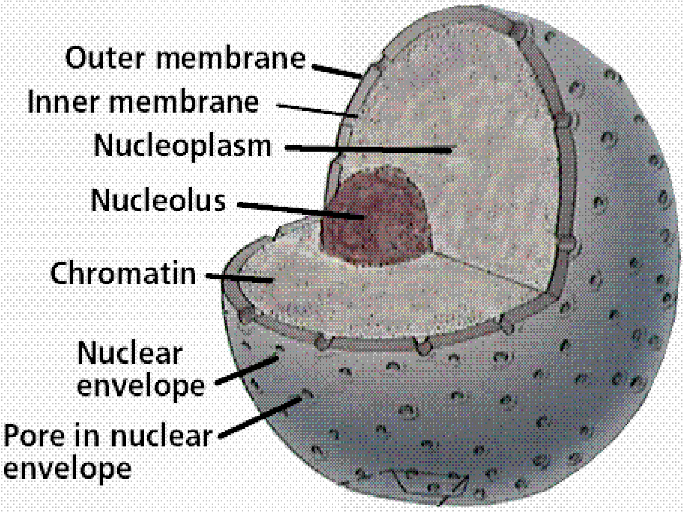
Nucleus

- **The nucleus is the genetic control center of a eukaryotic cell.**
- **In most cells, there is only one nucleus. It is spherical, and the most prominent part of the cell, making up 10% of the cell's volume.**

Components of Nucleus

Average diameter of nucleus is 6 um, which occupies around 10% of cell volume.

1. Nuclear Envelope – pore riddled
2. Nucleoplasm – Fluid interior portion
3. Nucleolus – Dense cluster of RNA & Proteins – ribosomes
4. Chromatin – all DNA+ Proteins



Ultrastructure Of Nucleus

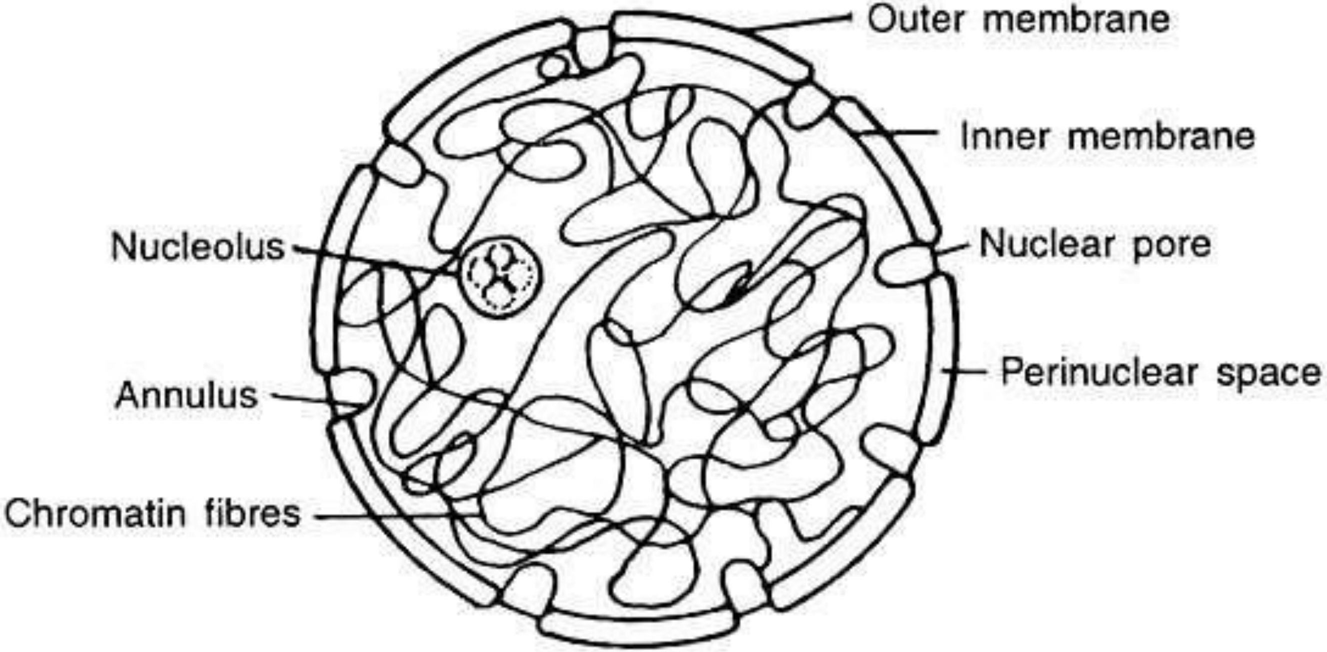


Fig. 2.1. Ultrastructure of Nucleus.

NuclearMembrane

- Also known as nuclear envelope or nucleolemma
- Separates the nuclear material from cytoplasm
- Consists of two lipid bilayers
- Outer membrane
- Inner membrane

- The nuclear envelope is a double-layered membrane perforated with pores, which control the flow of material going in and out of the nucleus.
- The outer layer is connected to the endoplasmic reticulum, communicating with the cytoplasm of the cell. The exchange of the large molecules (protein and RNA) between the nucleus and cytoplasm happens here.

Function Of Nuclear Membrane

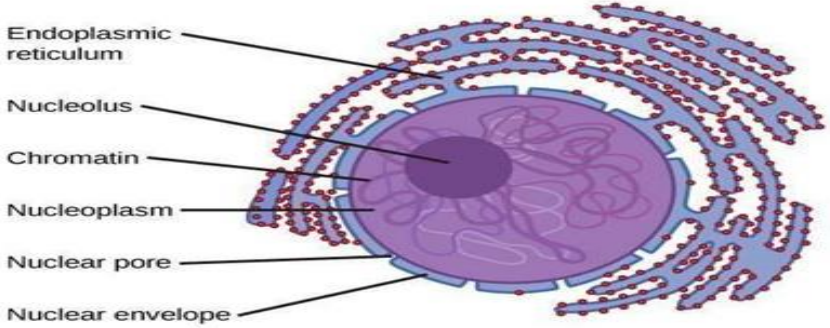
- Shape And Stability: Helps The Nucleus From Collapsing
- Compartmentalizing: Separates The Nuclear Material From Cellular Material
- Regulation Of Substances: Allow The Exchange Of Materials
- Communication: Develops A Chemical Connection Between Nucleus And Cell

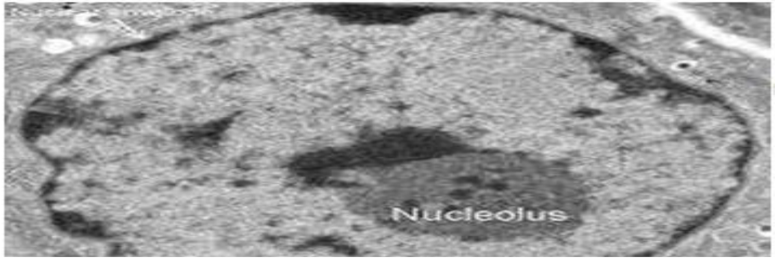
Nucleoplasm

- A jelly-like (made mostly of water) matrix within the nucleus
- Just like the cytoplasm found inside a cell, the nucleus contains **nucleoplasm**, also known as karyoplasm.
- All the other materials “float” inside
- Helps the nucleus keep its shape and serves as the median for the transportation of important molecules within the nucleus
- The **nucleoplasm** is a type of protoplasm that is made up mostly of water, a mixture of various molecules, and dissolved ions.
- It is completely enclosed within the nuclear membrane or nuclear envelope

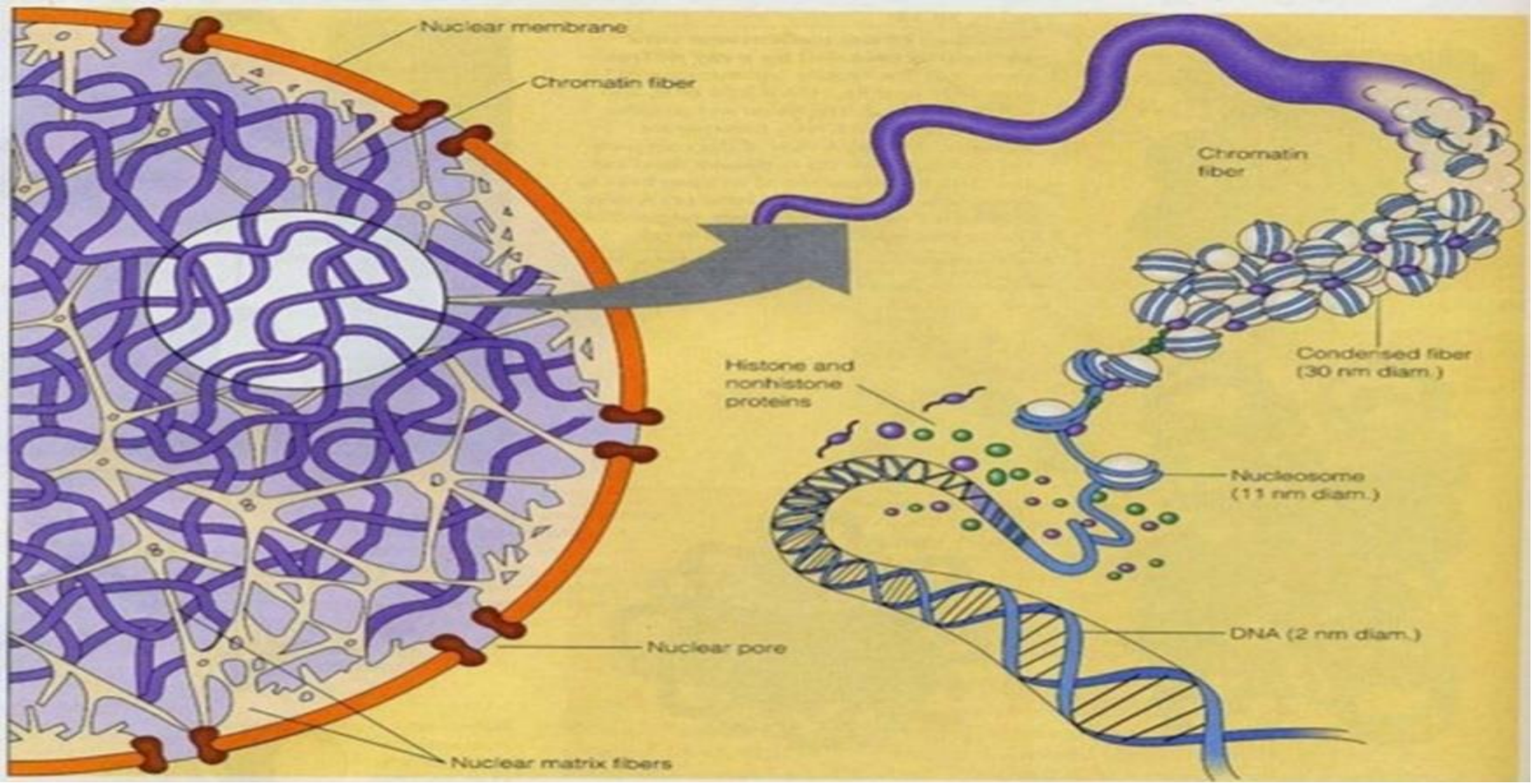
The Nucleolus

- Ribosome factory
- Large, prominent structures
- Doesn’t have membrane
- Directs synthesis of RNA
- The **nucleolus** takes up around 25% of the volume of the nucleus.

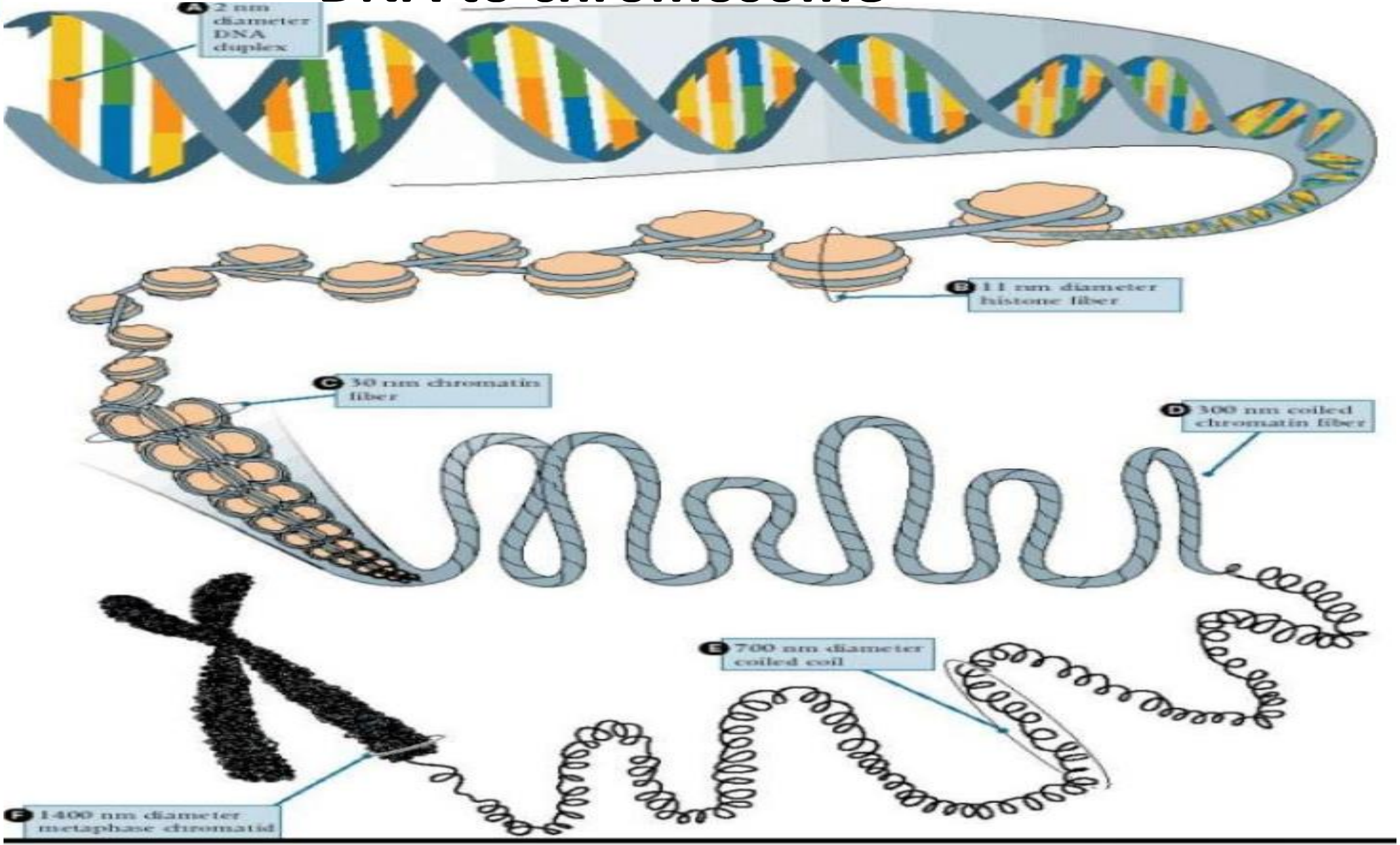




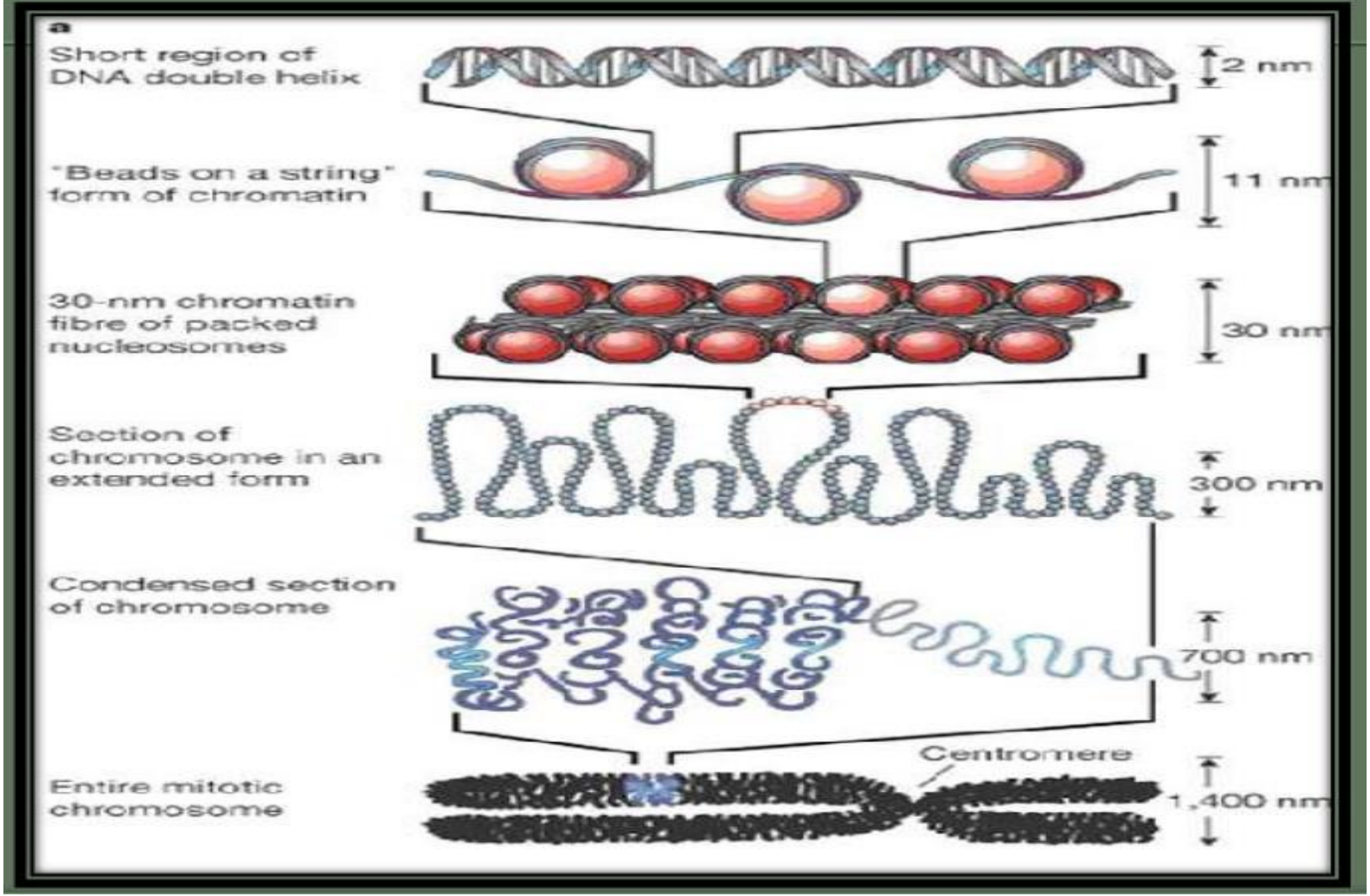
- This structure is made up of proteins and ribonucleic acids (rna). Its main **function** is to rewrite ribosomal RNA (rrna) and combine it with proteins.
- This results in the formation of incomplete ribosomes.


Nuclear membrane
Chromatin fiber
Chromatin fiber
Condensed fiber (30 nm diam.)
Histone and nonhistone proteins
Nucleosome (11 nm diam.)
DNA (2 nm diam.)
Nuclear pore
Nuclear matrix fibers

DNA to chromosome


A 2 nm diameter DNA duplex
B 11 nm diameter histone fiber
C 30 nm chromatin fiber
D 300 nm coiled chromatin fiber
E 700 nm diameter coiled coil
F 1400 nm diameter metaphase chromatid

https://www.youtube.com/watch?v=exDNUzKf9tU


a
Short region of DNA double helix
2 nm
"Beads on a string" form of chromatin
11 nm
30-nm chromatin fibre of packed nucleosomes
30 nm
Section of chromosome in an extended form
300 nm
Condensed section of chromosome
700 nm
Entire mitotic chromosome
Centromere
1,400 nm

DNA (DEOXYRIBONUCLEIC ACID)

Phoebus levene

Friedrich Miescher

Courtesy of Mr. Courvoisier, Portrait Sammlung.
University of Basel.
Noncommercial, educational use only.

Erwin Chargaff

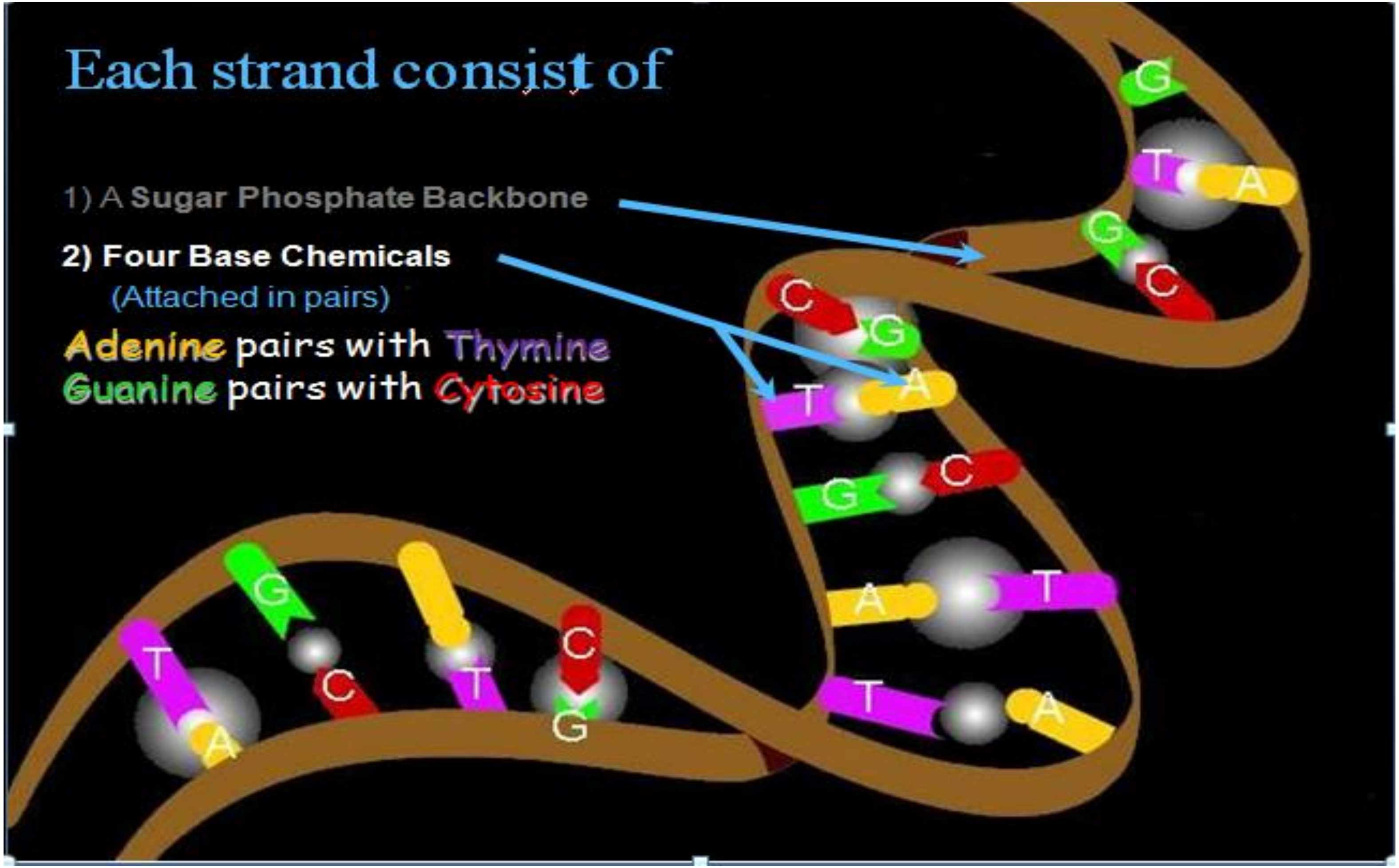
Discovery of DNA structure

James Watson

Francis Crick

Rosalind Franklin

Maurice Wilkins



Each strand consist of

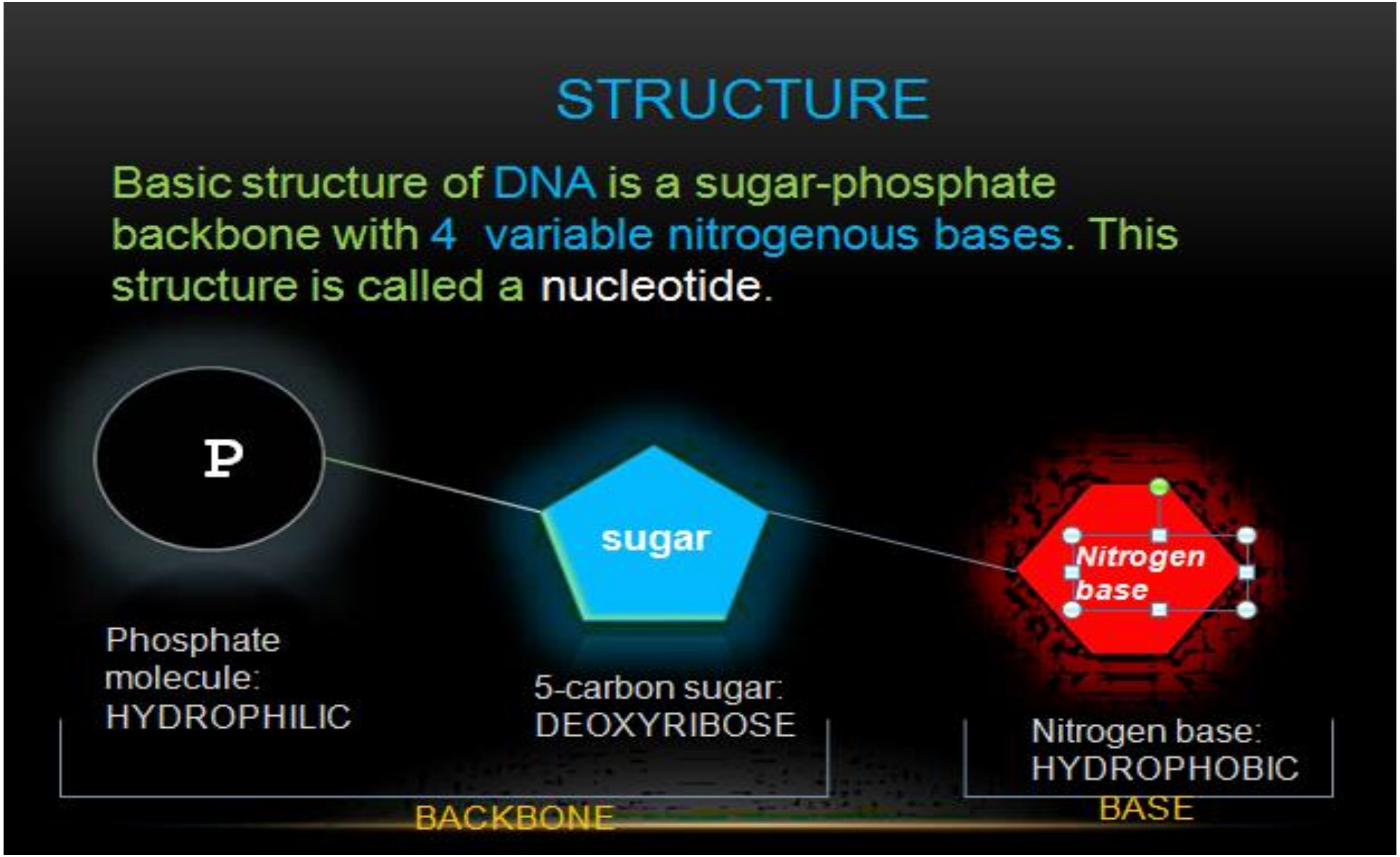
1) A **Sugar Phosphate Backbone**

2) Four Base Chemicals

(Attached in pairs)

Adenine pairs with Thymine

Guanine pairs with Cytosine



STRUCTURE

Basic structure of DNA is a sugar-phosphate backbone with 4 variable nitrogenous bases. This structure is called a nucleotide.

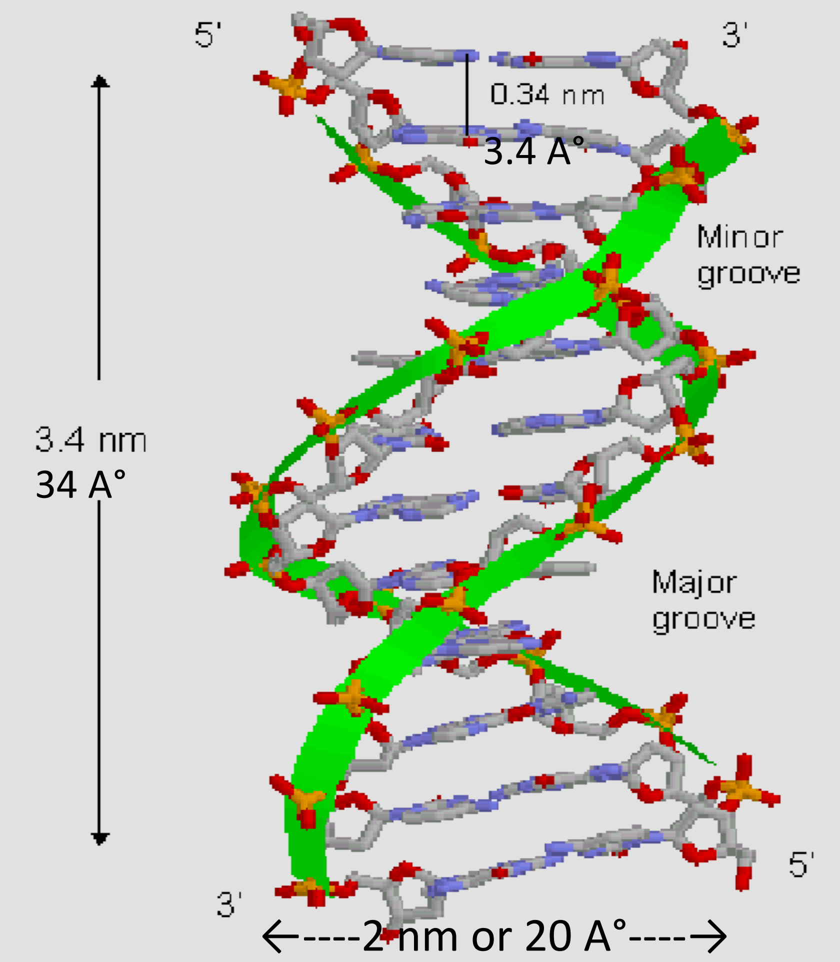
Phosphate molecule: HYDROPHILIC

5-carbon sugar: DEOXYRIBOSE

Nitrogen base: HYDROPHOBIC

BACKBONE

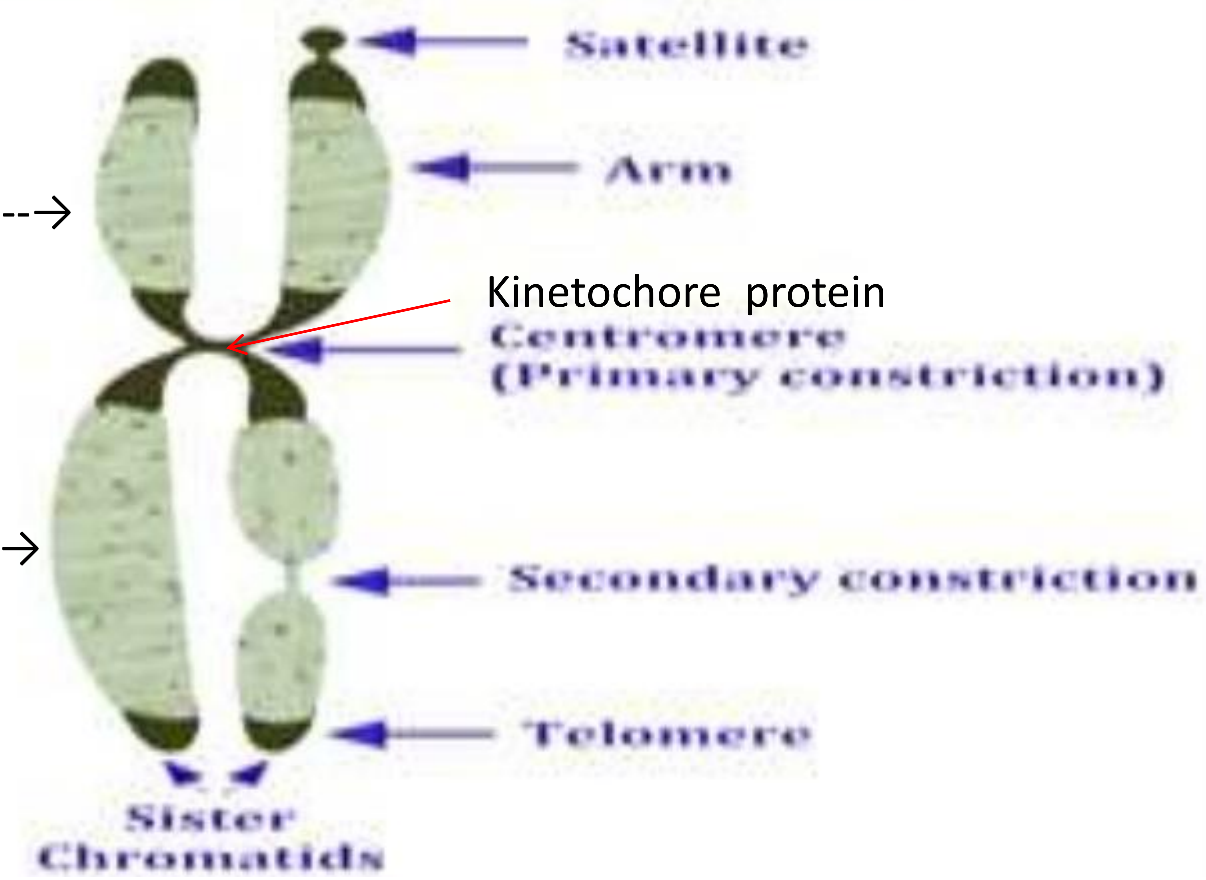
BASE


5'
3'
0.34 nm
3.4 A°
Minor
groove
3.4 nm
34 A°
Major
groove
5'
3'
←----2 nm or 20 A°----→

Briefly - Comparing nucleic acids

	DNA	RNA
Phosphate group	Yes	yes
Pentose sugar	Deoxyribose	Ribose
Bases	ACTG	ACUG
Types	1	3 need to know 2
Polymer	Yes of nucleotides	Yes of nucleotides
Size	v.v. big	smaller

Morphology of Chromosome

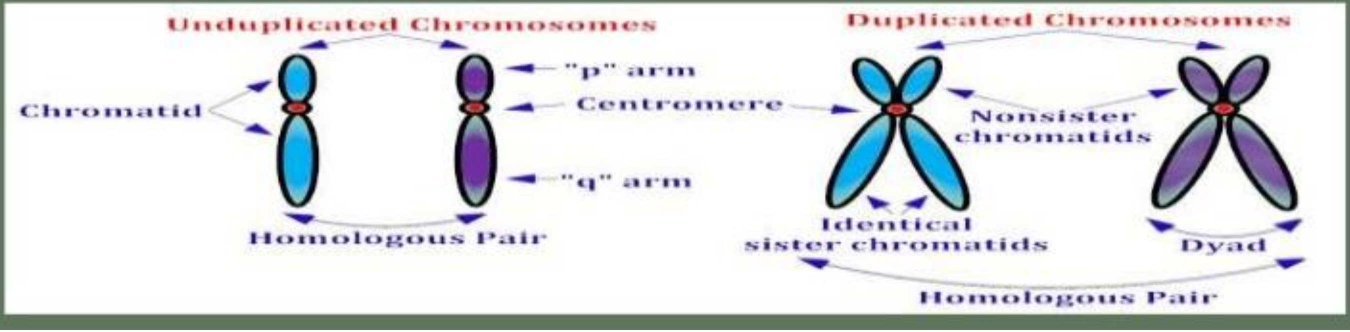


p- arm --->
Short in
size

Kinetochore protein

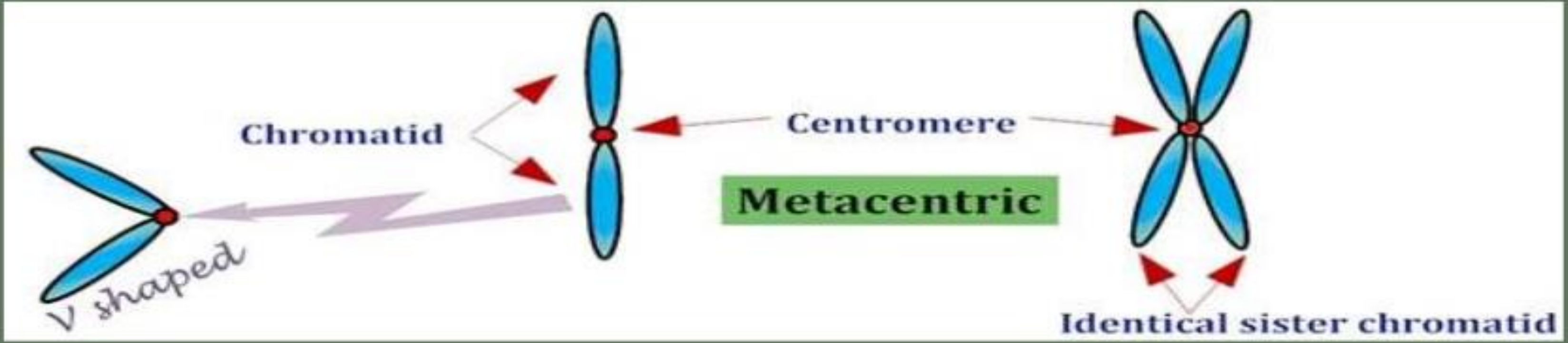
q- arm --->
Long arm
In size

- Chromosomes are classified according to the centromere position :
- At one end : Acrocentric
- Closer to one end: Submetacentric
- Middle: Metacentric
- Each chromosome has two arms, labeled **p (the shorter of the two)** and **q (the longer)**.
- The p arm is named for **"petite"** meaning **"small"**; the q arm is named q simply because it follows p in the alphabet.



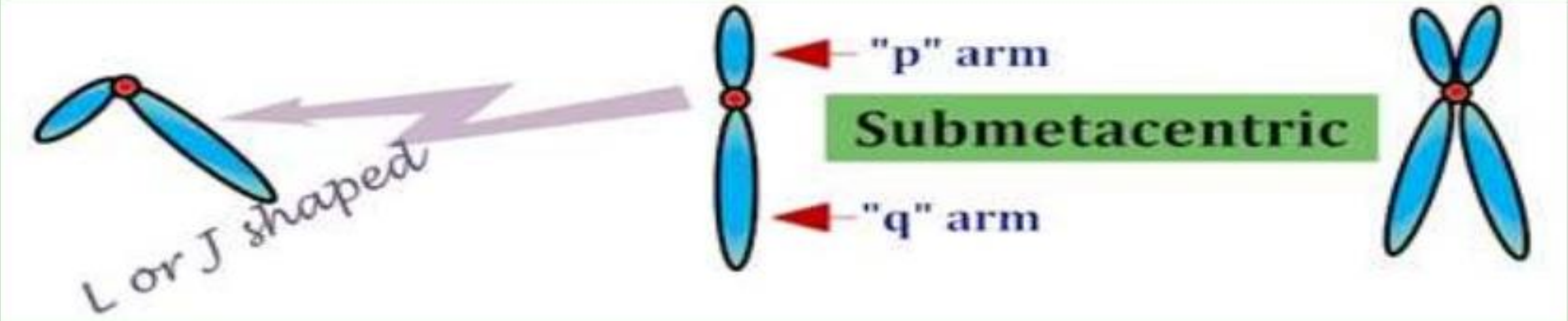
Metacentric chromosome

- The centromere is located in the centre of chromosomes, i.e. the centromere is median. The centromere is localized approximately midway between each end and thereby two arms are roughly equal in length.
- Metacentric chromosome take V shape during anaphase.



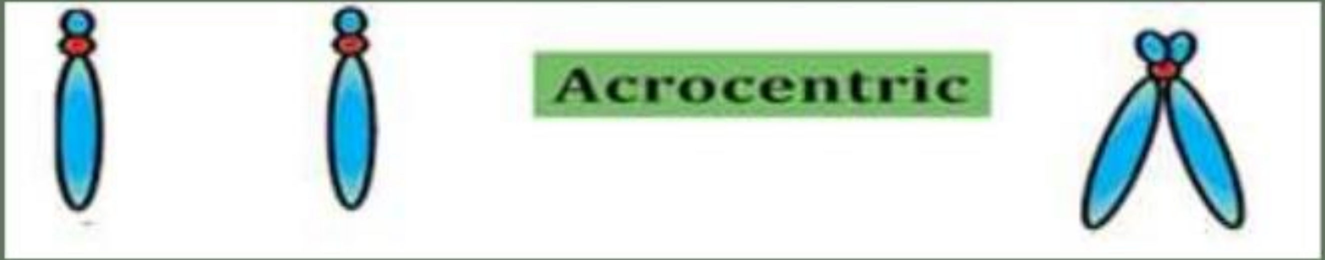
Submetacentric Chromosome

- Centromere is located on one side of the central point of a chromosome. Centromere is submedian giving one longer and one shorter arms.
- Submetacentric chromosome may be J or L shaped during anaphase.



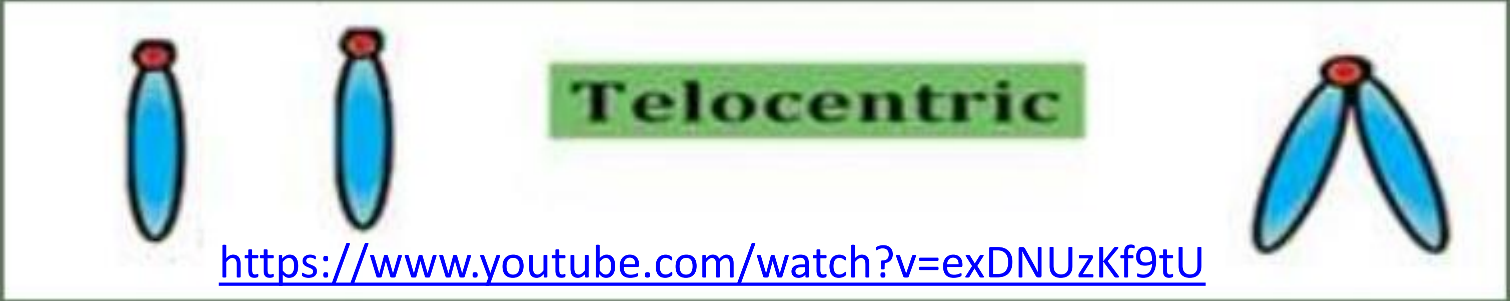
Acrocentric Chromosome

- The centromere located close to one end of chromosomes. The centromere is more terminally placed and forms very unequal arm length (The "acro-" in acrocentric refers to the Greek word for **"peak"**).
- The **p (short)** arm is so short that is hard to observe, but still present.
- Acrocentric chromosome may be rod shape during anaphase.



Telocentric Chromosome

- Centromere located at one end of chromosome (at terminal part of chromosome) lies at one end.
- Telocentic chromosome may be rod shape during anaphase.

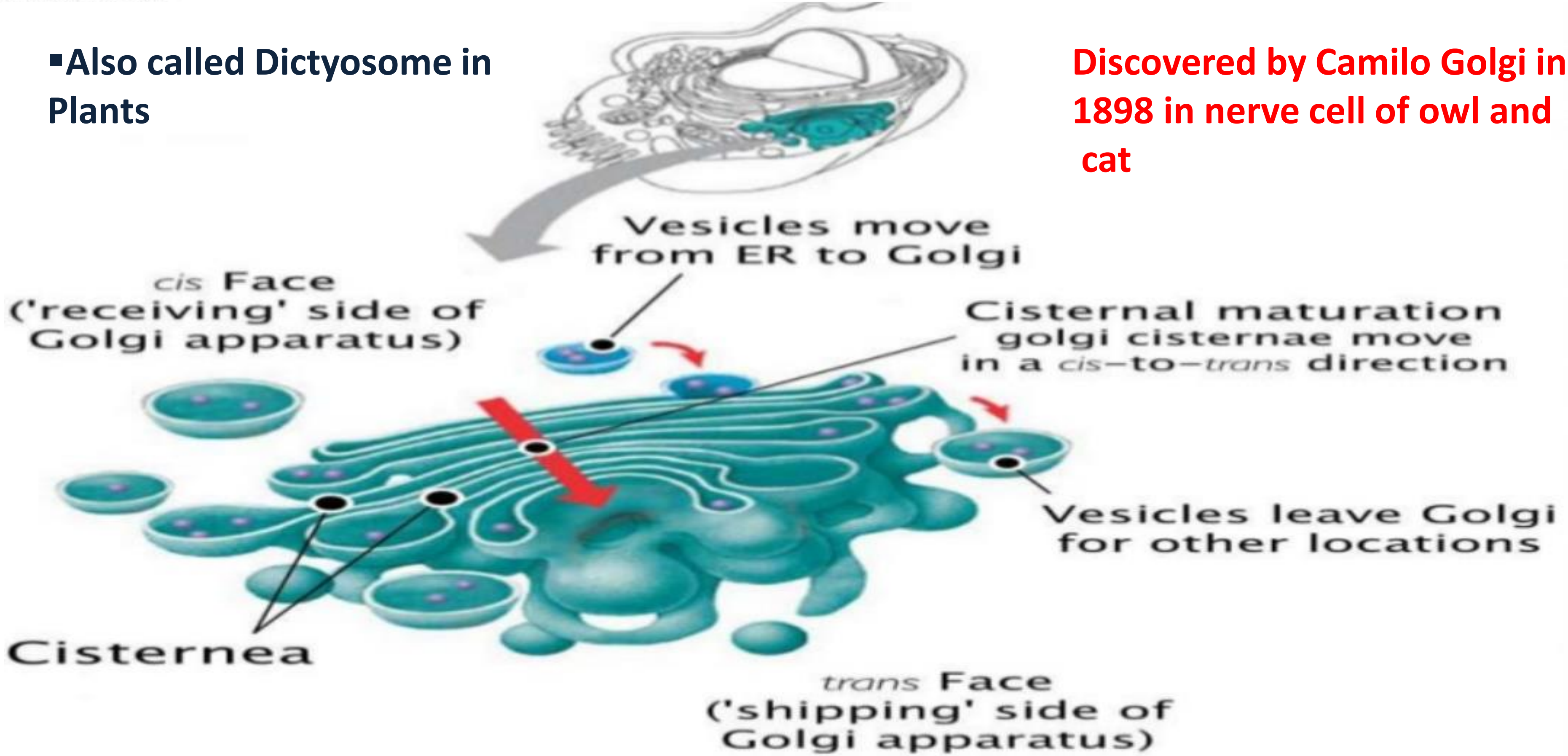


https://www.youtube.com/watch?v=exDNUzKf9tU

Golgi body or Golgi apparatus

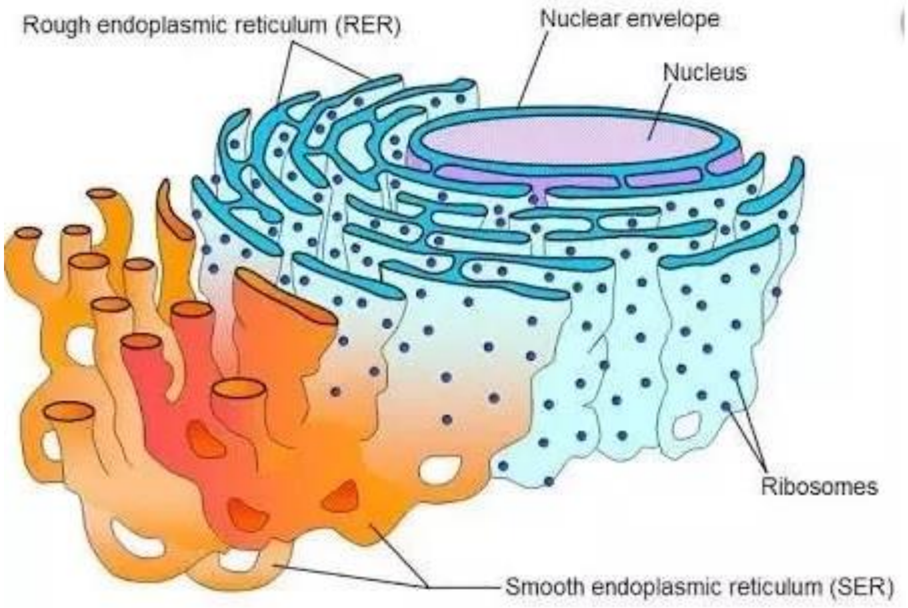
- **Also called Dictyosome in Plants**

Discovered by Camilo Golgi in 1898 in nerve cell of owl and cat


Vesicles move from ER to Golgi
cis Face ('receiving' side of Golgi apparatus)
Cisternal maturation golgi cisternae move in a *cis*–to–*trans* direction
Vesicles leave Golgi for other locations
Cisternea
trans Face ('shipping' side of Golgi apparatus)

Functions of golgi body

- It is involved in **secretion**, formation of carbohydrates, **glycoproteins**, **cell wall**, **cell membrane**, **lysosomes**, **acrosome of sperms** and **cell plate** formation


Rough endoplasmic reticulum (RER)
Nuclear envelope
Nucleus
Ribosomes
Smooth endoplasmic reticulum (SER)

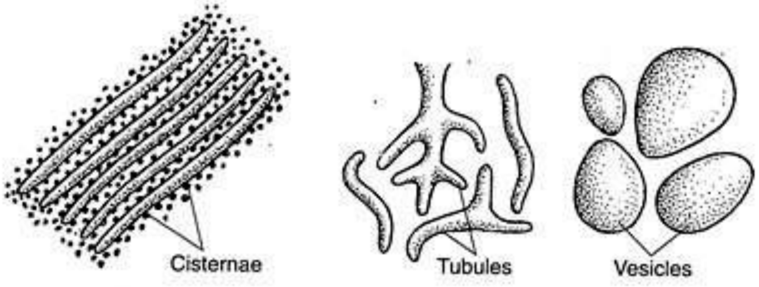


Fig. 2.42: Different forms of endoplasmic reticulum

Endoplasmic reticulum

- ER is a three dimensional complicated and interconnecting system of membrane lined channels that can run through the cytoplasm.
- It remains continuous with the plasma membrane, nuclear envelope and Golgi body.
- It is made up with cisternae, vesicles and tubules.
- It is of two type- A) RER (Rough Endoplasmic Reticulum)
  B) SER (Smooth Endoplasmic Reticulum)

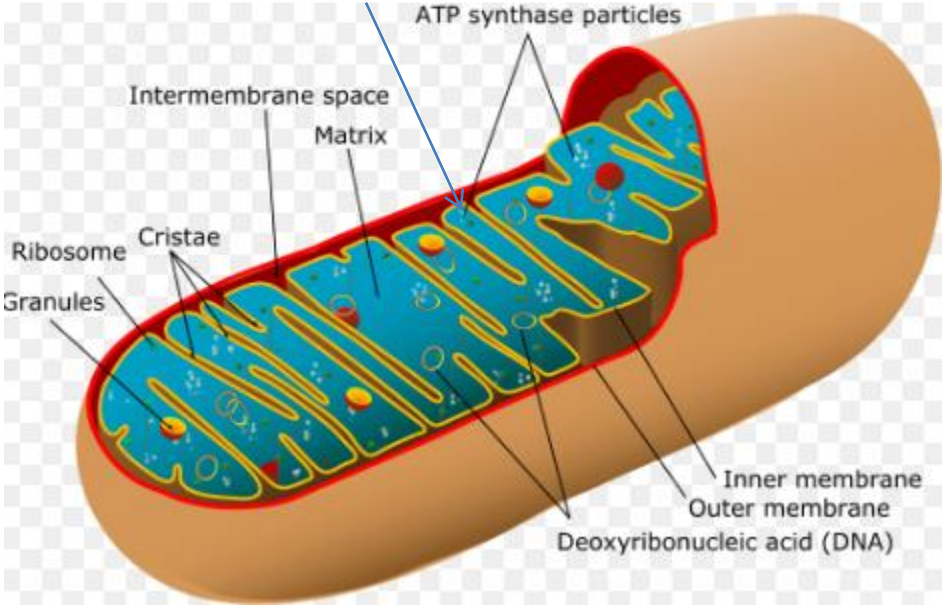
https://www.youtube.com/watch?v=f5ikERQCE6M

Function of ER

- **It is intracellular transport system for various substances.**
- **ER forms a Network in cytoplasmic reticulum matrix,giving mechanical support to the cell.**
- **Protein Synthesis.**
- **Detoxification of harmful compounds like toxins and drugs.**
- **Synthesis of lipids in collaboration with golgi complex on SER surface.**

Mitochondria (Fo-F1 complex or Oxysome)

- Mitochondria have a double membrane and corresponding **intermembrane space**.
- The space inside the organelle is the matrix.
- The inner membrane is arranged in cristae in order to increase the surface area available for energy production via the electron transport chain and F1-F0 ATP-ase in a process known as **oxidative phosphorylation**.
- The **outer membrane** contains porins which allow movement of ions into and out of the mitochondrion.
- The matrix contains **free DNA** and free ribosomes which help to synthesise some lipids and proteins.
- The matrix also contains enzymes required for the TCA (Kreb's) cycle.



Plastids

Chloroplast

It is green in colour because of chlorophyll and carry out Photosynthesis to produce starch.

Chromoplast

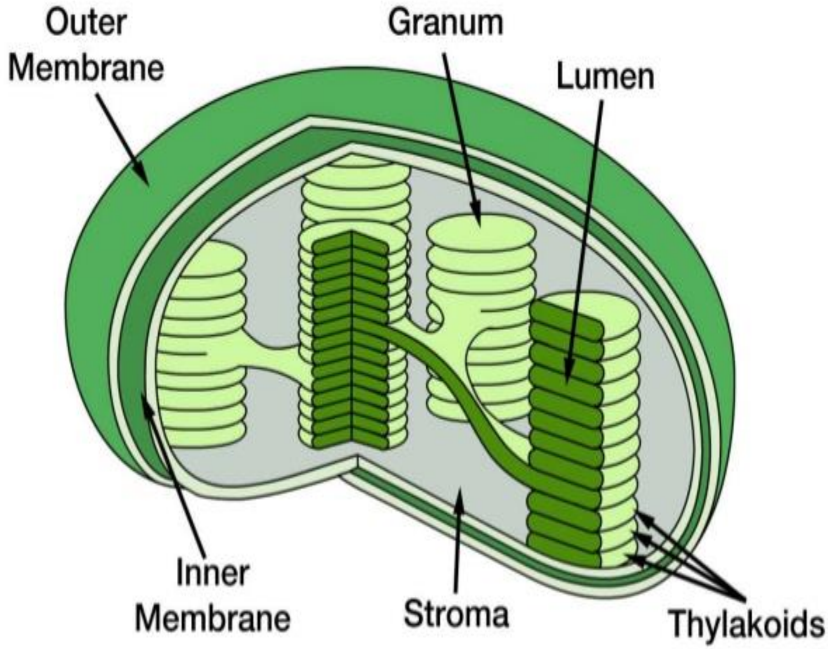
- **Chromoplasts** synthesize and store pigments such as orange carotene, yellow xanthophylls, and various other red pigments.

Leucoplast

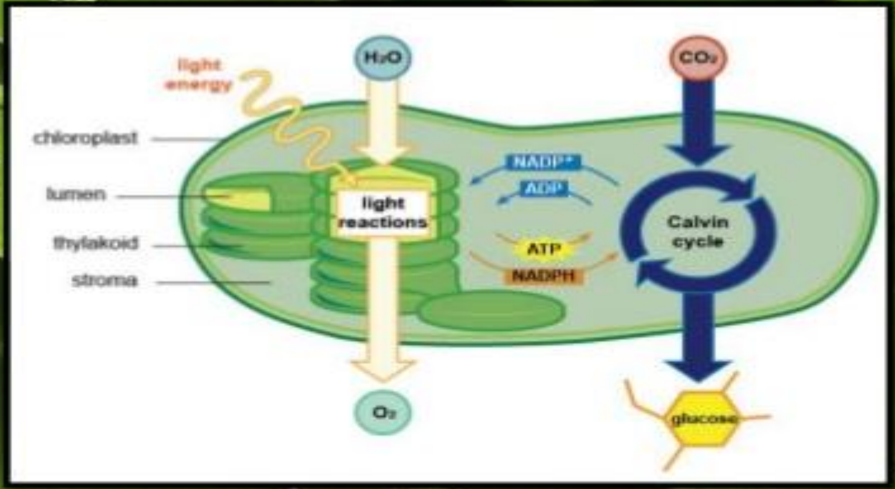
- It is colourless
- It is of three type

a) Aleuroplast
(which stores protein
b**) Elaioplast**
(which stores oil)
c) Amyloplast
(which stores starch)

Chloroplast



FUNCTIONS OF CHLOROPLAST



→ Chloroplast is the site for photosynthesis

Light reaction → Thylakoid membranes

Dark reaction → Stroma.

→Chloroplast is the site for photorespiration.

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